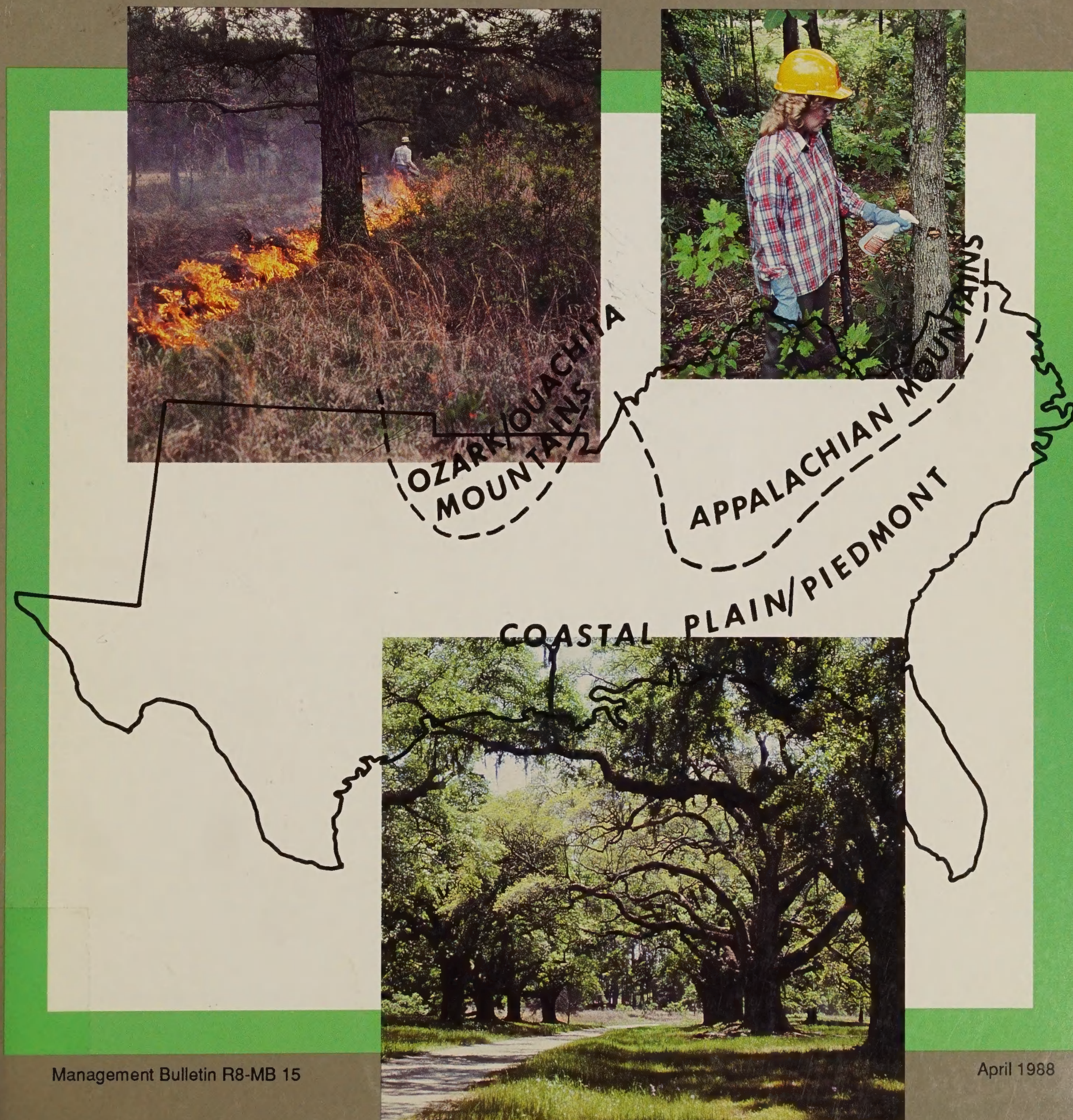
United States
Department of
Agriculture

Forest Service
Southern Region

Draft Environmental Impact Statement

VEGETATION MANAGEMENT in the Coastal Plain/Piedmont

VOLUME I



Management Bulletin R8-MB 15

April 1988

INVITATION TO REVIEW THE DRAFT EIS

Dear Reader:

Here is the Draft Environmental Impact Statement (DEIS) for Vegetation Management on National Forests and National Grasslands of the Coastal Plain/Piedmont area. During January 1987, we asked for your suggestions on issues. Interested individuals helped us identify 11 issues, and we would appreciate your help in reviewing the Draft EIS.

We have examined eight alternatives which represent a range of possible approaches to vegetation management (one proposes no action). The preferred alternative is alternative G. All alternatives reflect our effort to address issues you identified. They propose programs that:

- Consider effects from intensive site-disturbing methods.
- Minimize the effects of herbicides to people, wildlife, and the environment, and allow aerial application (alternatives G and H).
- Achieve desired objectives for other resource outputs, while promoting habitat conditions for a variety of plant and animal species and enhancing conditions for recovery of threatened, endangered, or sensitive species.
- Expand opportunities for prescribed fire that will simulate natural occurrences. Minimize impacts on air quality and improve understory vegetation composition.
- Reduce risk of injury to workers using manual methods.
- Enhance visual quality along right-of-way corridors emphasizing timing of activities and promoting flowering vegetation.

The Draft EIS and appendices are bound separately. If you did not request the appendices, they were not sent to you. If you now wish to have a copy, please contact me and I will immediately send you a copy.

As you begin your review and prepare to comment, let me suggest some things that will assist your review.

- If you're interested in a quick look at the entire process and results, read the summary beginning on page i.
- Each chapter begins with a very brief outline of what information is contained in the chapter and how it is organized.

Remember, for us to be able to use your comments, you need to respond by the due date. To assist you, we have provided a postage-paid response form on the next page. Our address is listed on the cover sheet of this document and is also on the response form. We're looking forward to your review and comment.

Sincerely,

Steve McCorquodale

STEVE MCCORQUODALE
Leader, Vegetation Management EIS Team

May 16, 1988

Tear at perforation

942227

RESPONSE FORM

We're providing this form to make it convenient for you to respond. You need not use this form though.

However you decide to respond, please help us by making specific and meaningful comments. Have we done an adequate scientific analysis? Do the Alternatives respond to your concerns?

Comments on Scientific Analysis:

Why?

Comments on Alternatives:

Why?

Other:

Why?

(use additional sheets as necessary)

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To return this comment sheet, fold and staple with USDA Forest Service address outside and drop in the mail (no postage necessary).

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DRAFT Environmental Impact Statement for

VEGETATION MANAGEMENT

in the Coastal Plain/Piedmont

USDA Forest Service | Alabama, Florida, Georgia, Louisiana, Mississippi, North Carolina,
Southern Region | South Carolina, Texas

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Comments Must Be Received By: **August 25, 1988**

Abstract

This environmental impact statement presents eight alternative ways to manage vegetation on Coastal Plain/Piedmont national forests of the USDA Forest Service's Southern Region. These alternatives range from no treatment to maximum vegetation control. Treatment alternatives use different mixes of methods and vary numbers of acres treated so as to present a wide array of possible approaches. Effects of each alternative on the physical and biological environment and on social and economic conditions are presented. Alternative G is the Forest Service's preferred alternative. Comments must be received by ___ **August 25, 1988** _____.

Note To Reviewers

Reviewers should provide the Forest Service with comments during the review period. This will enable the Forest Service to analyze and respond to comments at one time and to use the information to prepare the final environmental impact statement, thus avoiding undue delay in the decision-making process. Reviewers have an obligation to structure their participation in the National Environmental Policy Act process so that it is meaningful and alerts the agency to reviewers' positions and contentions, Vermont Yankee Nuclear Power Corp. v. NRDC, 435 U.S. 519, 553 (1978). Environmental objections that could have been raised at the draft stage may be waived if not raised until after completion of the final environmental impact statement, Wisconsin Heritages, Inc. v. Harris, 490 F. Supp. 1334, 1338 (E.D. Wis. 1980). Comments should be specific and should address the adequacy of the statement or merits of the alternatives discussed.

SUMMARY

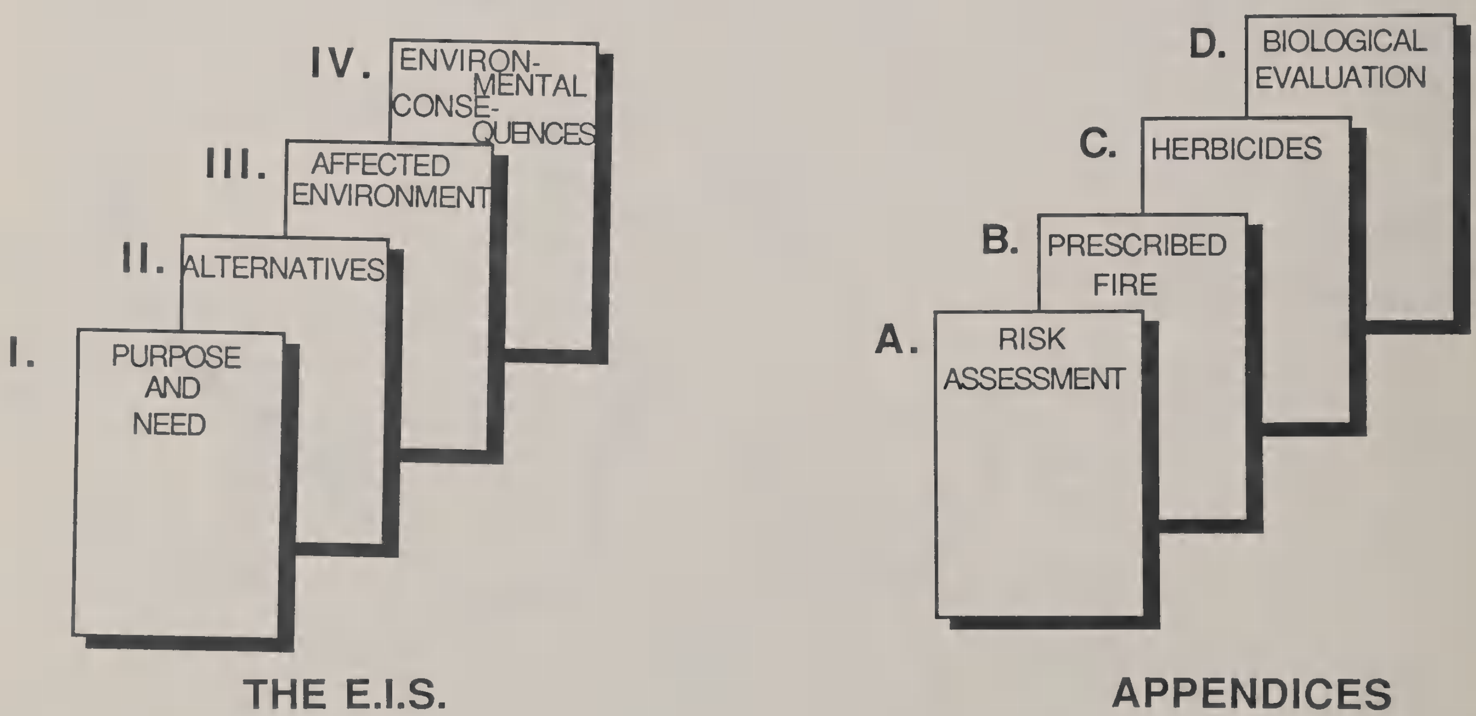
Introduction

This summary introduces you to the Environmental Impact Statement (EIS) for vegetation management on national forests in the Coastal Plain/Piedmont. This area includes all of Florida, Louisiana, Mississippi, and Texas, and parts of Alabama, Georgia, North Carolina, and South Carolina.

Vegetation management is the manipulation of plants by means other than timber harvest. It is done to help young trees survive and grow, to provide a variety of wildlife habitats, to maintain plants used by grazing animals, to reduce hazardous fuels, and to maintain safe and efficient travelways and utility lines.

The EIS analyzes effects of vegetation management methods on human health and safety, wildlife and aquatic animals, threatened and endangered species, vegetation, soil, water, air, rights-of-way, visual quality, cultural resources, wildfire, and social and economic conditions. Based on issues raised by the public, the document evaluates eight alternatives that differ with respect to acres treated, mix of methods, and intensity of tools available in each method. **Alternative G is the preferred alternative.** This alternative increases use of prescribed fire and herbicides for vegetation management, decreases use and intensity of mechanical methods, and introduces limited use of aerially applied herbicides. Prescribed fires are low to moderate intensity, and priority is to use herbicides and application methods that pose minimum risks to humans, wildlife, and non-target plants.

Chapters I through IV form the heart of the EIS. Chapter I defines the scope of decisions and displays issues. Chapter II explains each alternative, describes methods and tools, prescribes measures to mitigate adverse environmental effects, and compares alternatives. Chapter III describes the environment of the Coastal Plain/Piedmont. Chapter IV presents detailed analyses of environmental effects based on extensive scientific research. This summary presents highlights of these chapters.



The EIS also contains four major appendices. Appendix A is the Risk Assessment, a complex scientific document that analyzes herbicide risks to human and wildlife health. These risks are a product of the potency of each chemical and the degree of exposure to it. The evaluation compares herbicide doses people and animals may get with doses shown to be safe in laboratory studies. Risks are evaluated for workers, the public, and terrestrial and aquatic animals. Each herbicide is analyzed for its potential to cause toxic and other effects such as cancer, mutations, and birth defects. Appendices B and C discuss effects of prescribed fire and herbicides on soil and water. These appendices contain large bodies of research data under one cover and thus improve ease of accessibility for readers interested in our technical analyses. Appendix D is a biological evaluation of the effects of the preferred alternative on threatened, endangered, proposed, and sensitive species.

Scope of Decisions

The Southern Region contains a variety of landscapes, plant communities, soil types, and climates. To account for some of these differences, the Region is divided into three areas to analyze vegetation management activities. This EIS covers the Coastal Plain/Piedmont area. Other EIS's will cover the Appalachian Mountains and Ozark-Ouachita Mountains.

This EIS accepts the land allocation and resource output decisions of the Forest Land and Resource Management Plans. It evaluates various vegetation management methods and tools needed to achieve Plan goals. The makeup of methods, tools, and mitigation measures in the selected alternative may require some changes in Plan direction.

The EIS analyzes general effects over broad areas. Since environmental conditions can vary greatly from site to site, each project must be evaluated for its own site-specific effects. The site-specific analyses may reference (tier to) this EIS and EIS's accompanying Plans as appropriate. Methods and tools available for use on the ground are limited to those specified in the selected alternative.

Public Issues

Nearly 900 people responded to a request to help identify 11 issues the EIS should address. These issues form the basis for developing and comparing alternatives. They express multiple concerns and values, many of which are opposed to each other.

Balance of Resources: At issue is the mix of resources and outputs produced. Some people believe that an increase in market outputs like timber conflicts with an increase in non-market outputs like aesthetics.

Prescribed Fire: This method is generally viewed as "natural" and needed for wildlife, some ecosystems, and wildfire control. Concern centers on season, frequency, and intensity of prescribed fire as they affect soil, water, and air.

Health and Safety: Concern is that risks of accidents and illness should be evaluated and minimized for forest workers and for the public.

Plant and Animal Diversity: This issue reflects concerns about potential loss of species from a site.

Communication: This issue involves how well the Forest Service explains its programs. The issue applies only indirectly to vegetation management. By fully disclosing effects, the EIS should help address this issue.

Costs: This issue reflects desires that low-cost methods be used and that employment opportunities be provided.

Soil Productivity: People are concerned that some methods may impair soil productivity through erosion, compaction, and loss of nutrients and soil organisms.

Water Quality: Concerns focus on potential adverse effects on drinking water and aquatic communities.

Herbicides: Many people fear that herbicides may have serious effects on human health and on non-target plants and animals.

Aerial Application: Some people fear that aerially applied herbicides increase risk to human health and non-target plants and animals. Others view it as essential for economical treatment of some areas.

Wildlife: This issue reflects concerns about potential adverse effects on game, non-game, and threatened and endangered species, and desires that vegetation be managed to enhance wildlife habitat.

Affected Environment

This EIS covers 4.6 million acres, on 23 national forests and two national grasslands, in the Coastal Plain/Piedmont. The Coastal Plain contains a flat lower segment along the coasts and the Mississippi River, a rolling middle segment, and a hilly upper segment. The Piedmont is a rolling to hilly upland dominated by eroded clay soils. The humid subtropical climate has hot, humid summers, mild winters, and ample rainfall.

Major vegetation groups are the oak-hickory-pine (loblolly-shortleaf pine) forests, southern mixed and sand pine scrub (longleaf-slash pine) forests, southern floodplain (bottomland hardwood) forests, and tallgrass prairies. There are 15 animal species and four plant species classified as threatened or endangered. Soils deficient in organic matter and nutrients occur mostly in the Piedmont, Upper Coastal Plain, loess (wind-deposited) uplands, and Florida. Aquifers yielding ample ground water are abundant in the Coastal Plain but scarce in the Piedmont. Most lakes occur in Florida, and most wetlands occur in the Lower Coastal Plain.

Vegetation management is presently done on an average of 553,500 acres per year, or 12 percent of national forest lands in the Coastal Plain/Piedmont. Of this total, 463,000 acres (83.6 percent) are now treated by prescribed fire; 59,000 acres (10.7 percent) by mechanical methods; 27,000 acres (4.9 percent) by herbicides; and 4,500 acres (0.8 percent) by manual methods. Biological methods are not used at present.

Vegetation Management Methods and Tools

The five methods evaluated by the EIS are prescribed fire, mechanical, manual, herbicides, and biological. The mix of these methods varies markedly by alternative.

Prescribed Fire

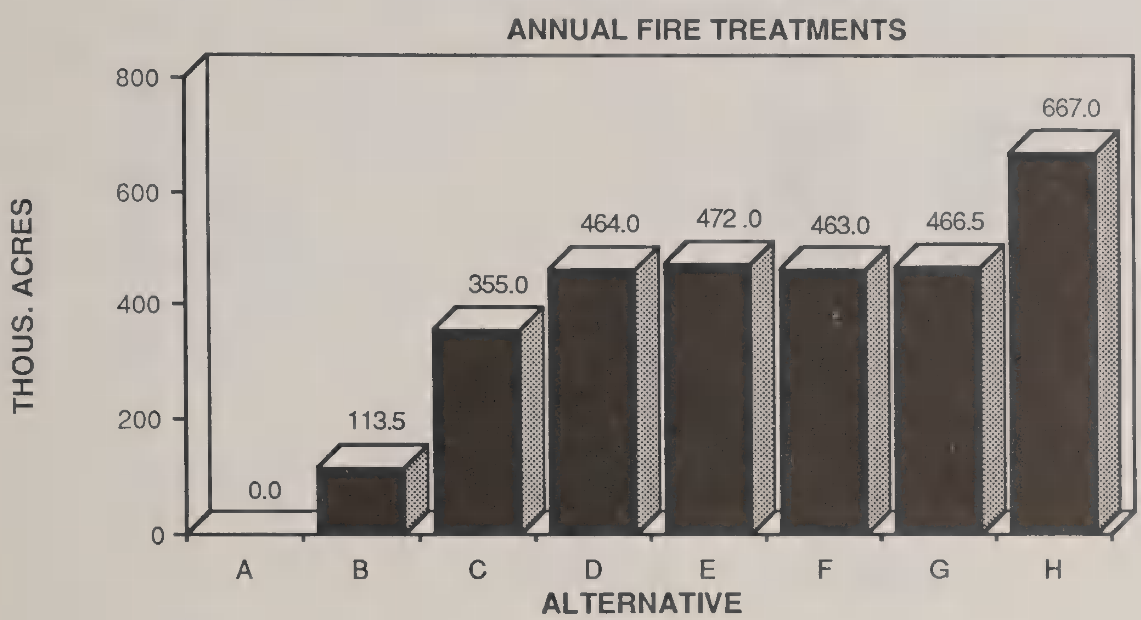
Prescribed fire is the planned use of fire under specific conditions. Six firing techniques are used that vary how a fire is set in relation to the wind. Prescribed fires may be set by hand using driptorches or by air using helicopters.

In general, light to moderate burns retain an effective ground cover of scorched or charred litter. Severe burns consume all litter and duff and alter the color and structure of mineral soil.

Mechanical Methods

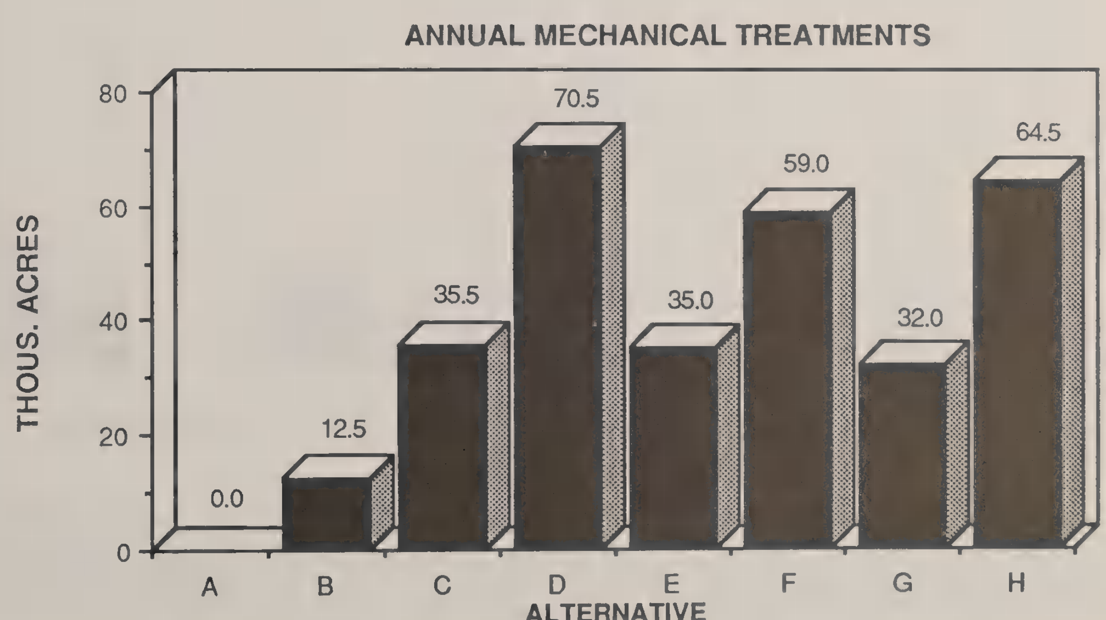
Mechanical methods involve the use of ground machines. They are classed into three groups based on their potential for soil disturbance by erosion, compaction, and nutrient loss.

Mowing tools cut small vegetation above ground. Chopping tools are bladed drums that roll over and chop vegetation. Shearing tools are tractor-mounted blades that cut vegetation above ground. Scarifying tools scoop small depressions in the soil at wide intervals. Ripping tools plow furrows at wide intervals. Mowing, chopping, shearing, scarifying, and ripping cause low soil disturbance.



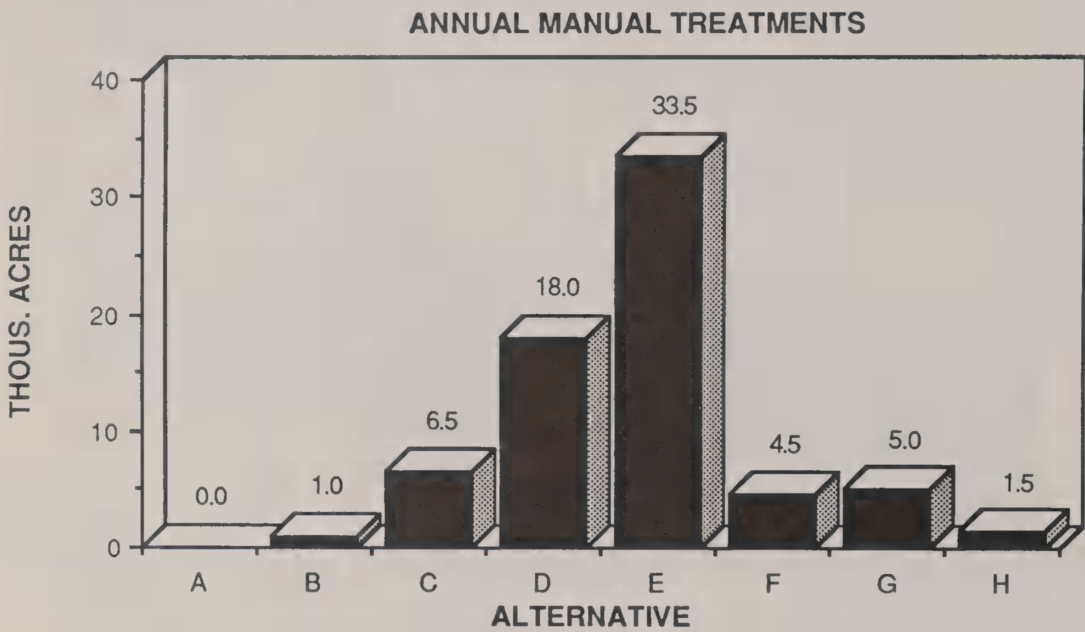
Piling and bedding cause moderate soil disturbance. Piling tools replace the dozer blade on tractors and roll vegetation, slash, and some litter into piles or windrows. Bedding tools are used on flat sites and pile topsoil and litter into elevated beds.

Raking and disking cause high soil disturbance. Unlike piling tools, raking tools push all litter and some topsoil into piles or windrows. Disking tools are used on slopes up to 20 percent and loosely till the soil.



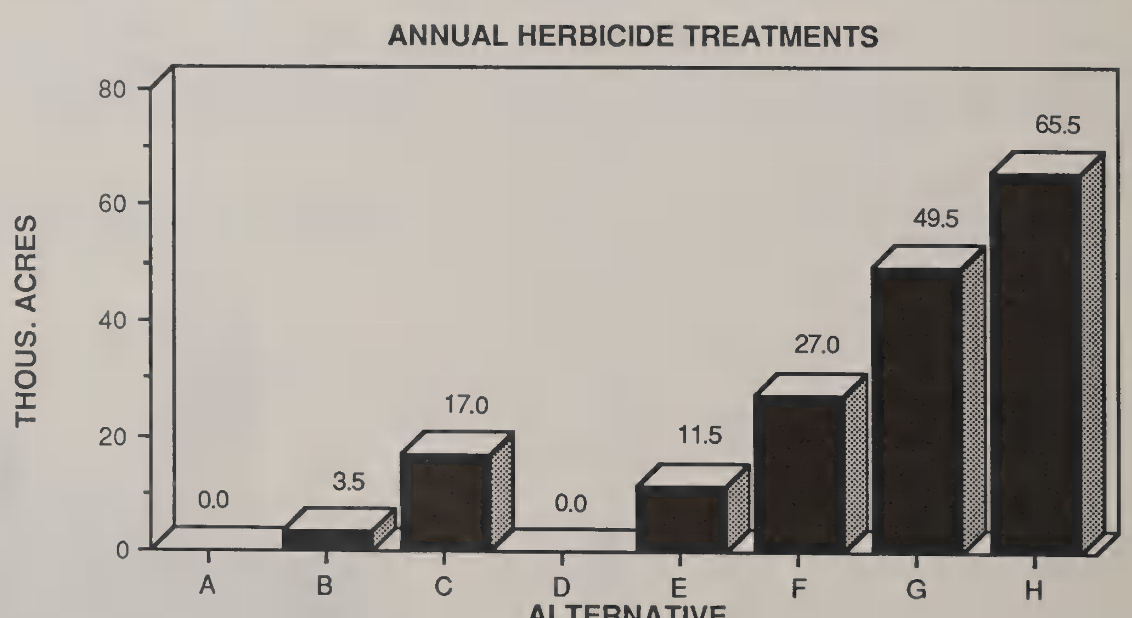
Manual Methods

Manual methods employ hand tools to cut vegetation above ground. Non-power tools are axes, brush hooks, and clippers. Power tools include chain saws and brush cutters.



Herbicides

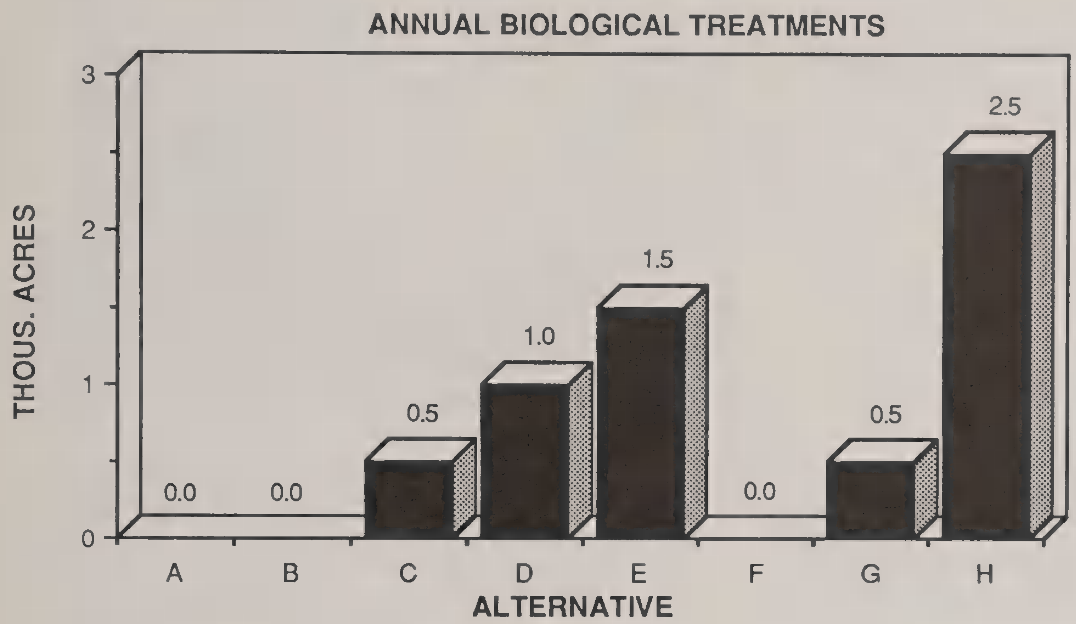
The 11 herbicides evaluated for use in the Southern Region are dicamba; fosamine; glyphosate; hexazinone; picloram; sulfometuron methyl; triclopyr; 2,4-D; 2,4-DP; imazapyr; and tebuthiuron. In addition, 3 additives (diesel oil, kerosene, and limonene) were analyzed for their effects on human and wildlife health.



Herbicides are used to kill or suppress target plants. They are applied in liquid or granule form by hand, machine, or air. Hand applications use backpack sprayers and tree injectors for liquids and hand-held spreaders for granules. Machine and helicopter applications use boom/nozzle sprayers for liquids and power spreaders for granules.

Biological Methods

The only biological method evaluated is the use of livestock within existing grazing allotments.



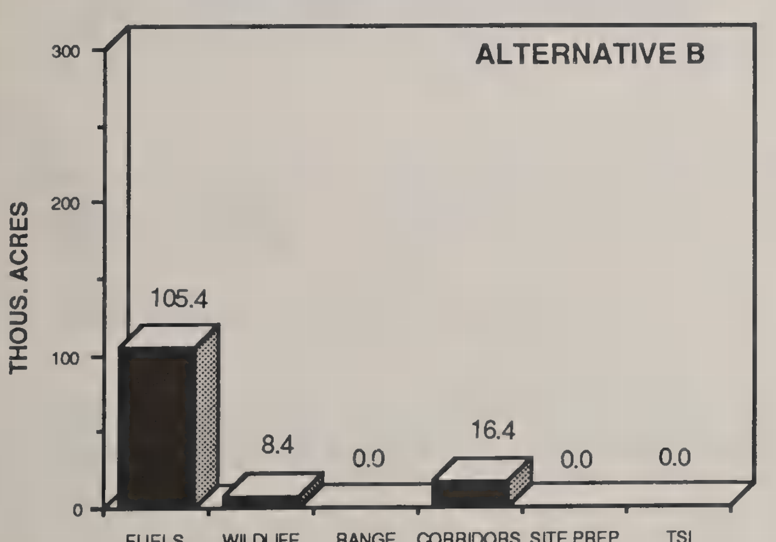
Alternatives

Eight alternatives were developed to respond to issues. They vary by acres treated per year, mix of methods, and intensity of tools used in each method.

Alternative A (No Action)

Vegetation management is not done. Existing vegetation is allowed to grow without manipulation.

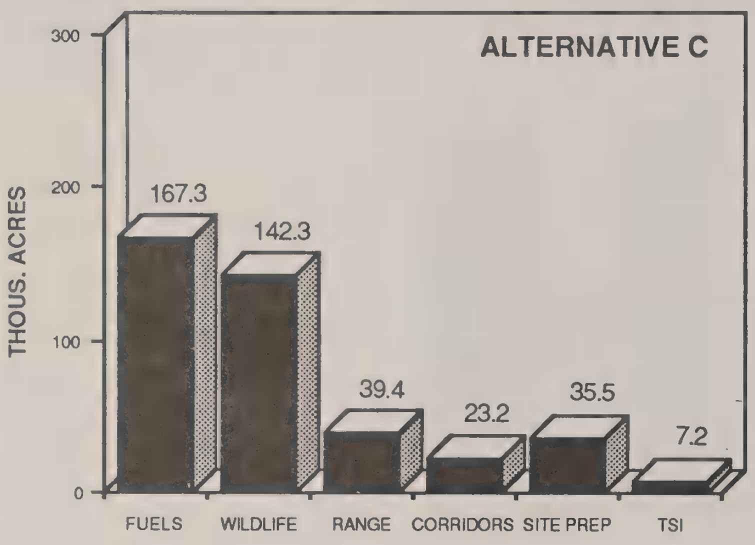
Alternative B



Vegetation management is done only to protect resources and public health and safety. Activities are limited to hazard fuel reduction, corridor maintenance, and protection of threatened and endangered species. Acres treated per year total 130,500. Use of herbicides and manual methods is minor, and biological methods are not used.

Herbicides are applied by hand. Priority is given to use of herbicides and application methods that pose minimum risks to humans, wildlife, and non-target plants. Mechanical treatments are limited to mowing. Only low-intensity, dormant season prescribed fire is used.

Alternative C



Vegetation management is restricted to methods that achieve selective control or cause limited site disturbance. All activities receive treatments, but only when critically needed. Acres treated per year total 414,500. Emphasis on prescribed fire and manual methods increases slightly from present, and use of biological methods is minor.

Herbicides are applied by hand. Priority is given to use of herbicides and application methods that pose minimum risks to humans, wildlife, and non-target plants. Mechanical methods cause low soil disturbance. Prescribed fire is of low intensity.

Alternative D

Herbicides are not used. Acres treated per year total 553,500. Manual and mechanical methods increase from present by 13,500 and 11,500 acres, respectively, to replace herbicides. Use of biological methods is moderate.

Mechanical methods cause low to moderate soil disturbance. Prescribed fire is of low to moderate intensity.

Alternative E

Manual methods and prescribed fire are the major means of vegetation control. Acres treated per year total 553,500. Manual methods increase from present by 29,000 acres, and herbicides and mechanical methods decrease by 15,500 and 24,000 acres, respectively. Use of biological methods is moderate.

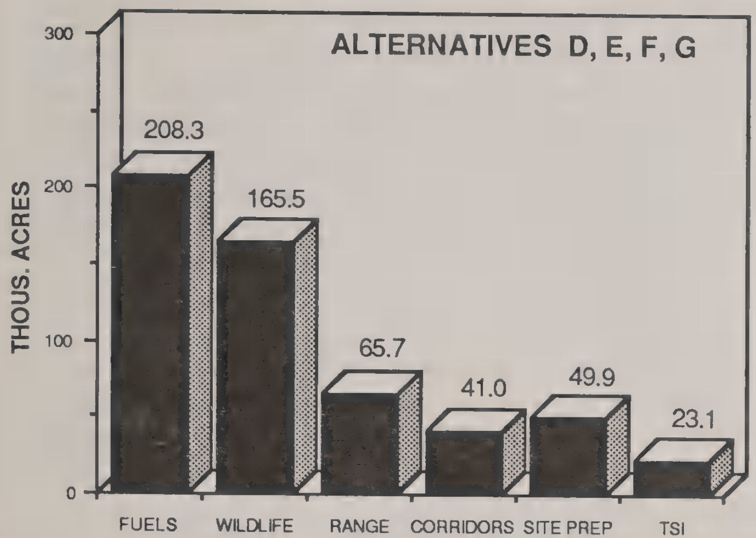
Herbicides are applied by hand and machine. Priority is given to use of herbicides and application methods that pose minimum risks to humans, wildlife, and non-target plants. Mechanical methods cause low to moderate soil disturbance. Prescribed fire is of low to moderate intensity.

Alternative F

This alternative continues present levels of treatment specified in Forest Land and Resource Management Plans. Acres treated per year total 553,500. Use of manual methods is minor, and biological methods are not used.

Herbicides are applied by hand and machine. Mechanical methods cause low to high soil disturbance. Prescribed fire is of low to high intensity.

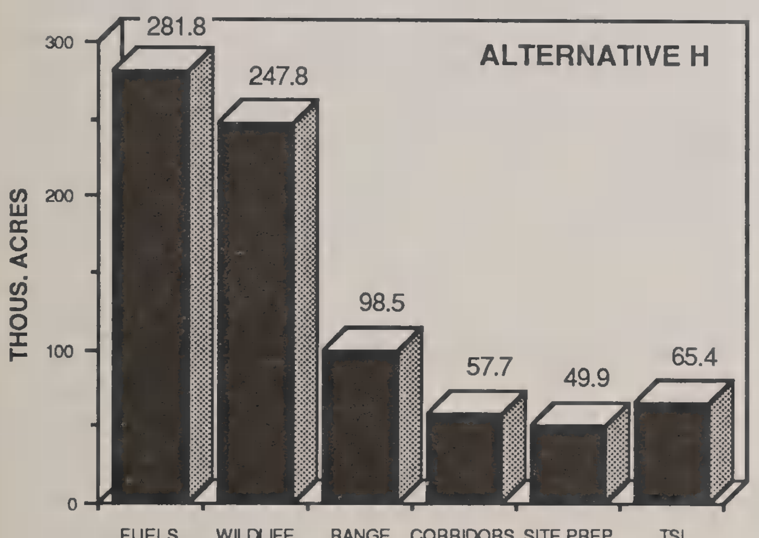
Alternative G (Preferred)



Prescribed fire and herbicides are the major means of vegetation control. Acres treated per year total 553,500. Herbicides increase from present by 22,500 acres, and mechanical methods decrease by 27,000 acres. Use of manual and biological methods is minor.

Herbicides are applied by hand, machine, and air. Priority is given to use of herbicides and application methods that pose minimum risks to humans, wildlife, and non-target plants. Herbicides are applied aerially on 7,000 acres per year. Mechanical methods cause low to moderate soil disturbance. Prescribed fire is of low to moderate intensity.

Alternative H



Vegetation management is done to achieve maximum vegetation control. Herbicides are broadcast at maximum effective rates, and intensive mechanical methods and prescribed fire are favored. Acres treated per year total 801,000. Emphasis on herbicides increases markedly from present, and biological methods are used aggressively.

Herbicides are applied by hand, machine, and air. Herbicides are applied aerially on 28,000 acres per year. Mechanical methods cause low to heavy soil disturbance. Prescribed fire is of low to high intensity.

Management Requirements and Mitigation Measures

Management requirements and mitigation measures are "do's" and "don't's" applied on the ground to assure that treatments accomplish their objectives and produce fewer adverse impacts and more benefits. Some requirements and measures are general and apply to all vegetation management methods. Others pertain only to one method. Analysis showed that they significantly reduce adverse environmental effects. Chapter II covers them in detail and discusses their effectiveness. They are summarized below.

General

Detailed site-specific analyses and biological evaluations are required for each project. Timber stand improvement guides ensure adequate tree stocking and growth. Stream stability is protected by retaining bank vegetation and preventing debris deposits. Cultural resources are inventoried and protected. Safety equipment is mandated for field workers. Methods and tools are matched to visual quality objectives, and treatments are timed to protect scenic values. Vegetation is treated to enhance variety of wildlife habitat and protect forage production. Corridors are managed to control erosion, protect public safety and facilities, and enhance wildlife, recreational, and visual values.

Prescribed Fire

Timing and intensity of burns are controlled to protect crop and wildlife trees and nesting animals, limit soil damage, and reduce erosion, sediment loads, and smoke emissions. Firelines are built and maintained to reduce erosion and sediment and protect wetlands. Burns are patterned to enhance variety of wildlife habitat.

Mechanical Methods

Erosion and sediment are reduced by mandating slope limitations, contour tillage, buffers along streams, and prompt revegetation. Treatments are timed to limit soil compaction. Roads, trails, and ditches are kept free of debris.

Herbicides

Choice of herbicide and method, rate, and timing of application are managed to reduce risks to humans, wildlife, and other environmental elements. Supervision and training of applicators are mandatory to reduce risks of accidents and exposure. Protective clothing and safety equipment are mandated to reduce exposure. Drift of herbicides is reduced by using special spray nozzles and applying during favorable weather. Precautions are specified to reduce risk of spills, and water or worker contamination. Water supplies and adjacent lands are protected by buffers.

Biological Method

Stocking and grazing patterns are controlled to reduce soil compaction and damage to trees, riparian vegetation, and stream banks.

Environmental Consequences

Chapter IV presents detailed analyses of effects of the vegetation management methods on various environmental elements. It also summarizes effects of alternatives on each element. The alternatives differ with respect to acres treated, mix of methods, and intensity of tools available in each method. Each of these factors influences the direction and severity of environmental effects. This section of the summary briefly discusses effects on key environmental elements.

Alternative A treats no acres. Alternatives B and C treat increasing numbers of acres, employ all methods, and use only low-disturbance tools. Alternatives D through G treat the present number of acres as detailed in Forest Land and Resource Management Plans. Alternative D eliminates the use of herbicides, while E through G employ all methods. Alternatives D, E, and G use low to moderate disturbance tools, while F also uses high disturbance tools such as severe slash burns, raking, and heavy disking. Alternative H treats the most acres, employs all methods, and increases use of high disturbance tools.

Human Health and Safety

All herbicides and additives are safe for the public when applied using typical rates and methods. However, 2,4-D, 2,4-DP, and tebuthiuron pose risks to workers using backpack sprayers. And 2,4-D poses risks to mixer/loaders. These risks are caused by the greater exposure for these workers, and can be mitigated to safe levels by changing chemicals, reducing application rate or exposure time, or using waterproof clothing. In general, worker exposure is reduced by aerial application.

Accidental injuries from other methods pose greater risks to workers than health impacts from herbicides. Accidents are most common and severe with manual methods. Prescribed fire poses the next highest risk. Alternative A poses the lowest overall risk to human health and safety because no tools are used and risks are limited to wildfires.

Wildlife

All herbicides and additives are safe for terrestrial and aquatic wildlife when applied using typical rates and methods. When applied at extreme rates, six chemicals pose risks to some species. Accidental spills of some chemicals into surface water would pose risks to some aquatic species.

Vegetation management benefits some wildlife species and harms others. For example, lack of treatment or low disturbance tools favor mid-late successional habitats and associated wildlife; whereas early successional habitats and wildlife are favored by more intensive treatments. Alternatives E and G provide the greatest variety of habitats and associated species, because they have the most balanced mix of low to moderate disturbance tools.

Threatened and Endangered Species

Some species occur only in habitats where no vegetation management occurs. Low toxicities to animals, low risk of exposure, and use of biological evaluations limit risks of adverse herbicide effects on listed animals. Since threatened or endangered plants may be extremely sensitive to herbicides, mitigation measures and biological evaluations are essential for protecting these plants.

Lack of treatment may prevent recovery of species which require periodic disturbance. Many species are fire-dependent, and some are sensitive to intensive or frequent treatments. Alternatives E and G both achieve full recovery and pose low risks to population viability due to their balanced mix of low to moderate disturbance tools.

Vegetation

Lack of treatment or use of low-disturbance tools favors woody species. High disturbance tools favor herbaceous species. Alternatives E and G use a mix of low-to-moderate-disturbance tools which promote the greatest variety of different species types.

Soil

Severe slash burns and raking pose high to extreme risks to soil productivity on all soils, mainly through loss of organic matter and nutrients. Moderate slash burns and piling pose low risks on some soils. Soil compaction is only significant for raking on clay and loam soils. Erosion is most severe after heavy disking.

Lack of underburns in Alternative A allows soil productivity in pine forests to deteriorate naturally through leaching and weathering, and increases occurrence and adverse effects of wildfires. Alternative C best protects soil productivity because only low-disturbance tools are used and underburns prevent soil deterioration and wildfire effects.

Water

No method significantly affects chemical water quality. Because herbicides are applied at low rates, are separated from streams and wells by buffers, and are subject to considerable downstream mixing and dilution, risks to water from typical application are very slight. Aerial herbicide application, however, increases risks of accidental pollution of streams.

In general, stormflows and sediment loads are increased slightly by low-to-moderate-disturbance tools, and substantially by high-disturbance tools like severe slash burns, raking, and heavy disking. Lack of underburns in Alternative A increases occurrence of severe wildfires. Alternative B best protects water quality because only low-disturbance tools are used and underburns prevent some wildfire effects.

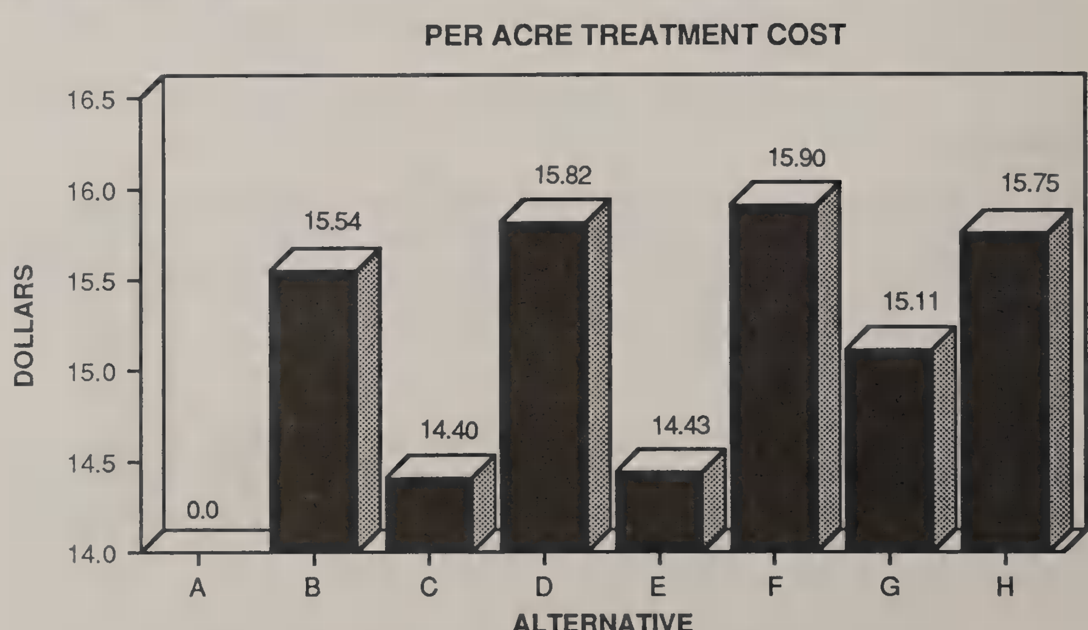
Air

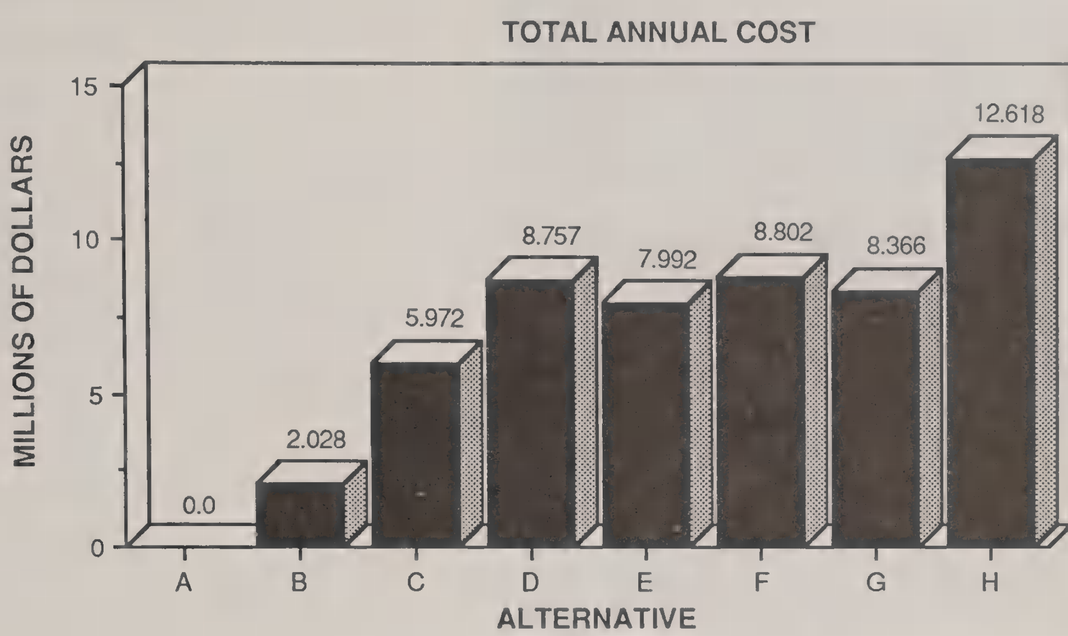
Emissions of pollutant gases (carbon monoxide, hydrocarbons, nitrogen oxides, sulfur oxides, photochemical oxidants) are generally not sufficient to pose significant risks to air quality. Particulate emissions are least for grassland burns and pine-grass underburns, moderate for slash burns and pine-light brush underburns, and highest for wildfires. Long-term exclusion of underburns can cause available fuels to triple and greatly increase acres burned by wildfires.

Alternatives C through G emit comparable amounts of smoke. Alternative C emits the least because prescribed fire is restricted but still sufficient to limit wildfire acres. Smoke emissions in alternative A are much more than those of alternatives C through G.

Economics

Direct per-acre costs are lowest for prescribed fire. Indirect costs (sacrificed outputs) are generally reduced as market outputs increase. Lack of treatment reduces outputs and induces damages to facilities such as roads which deteriorate from lack of maintenance. Alternatives E and G have the greatest advantage because their direct costs are among the lowest and their indirect costs are low to moderate.



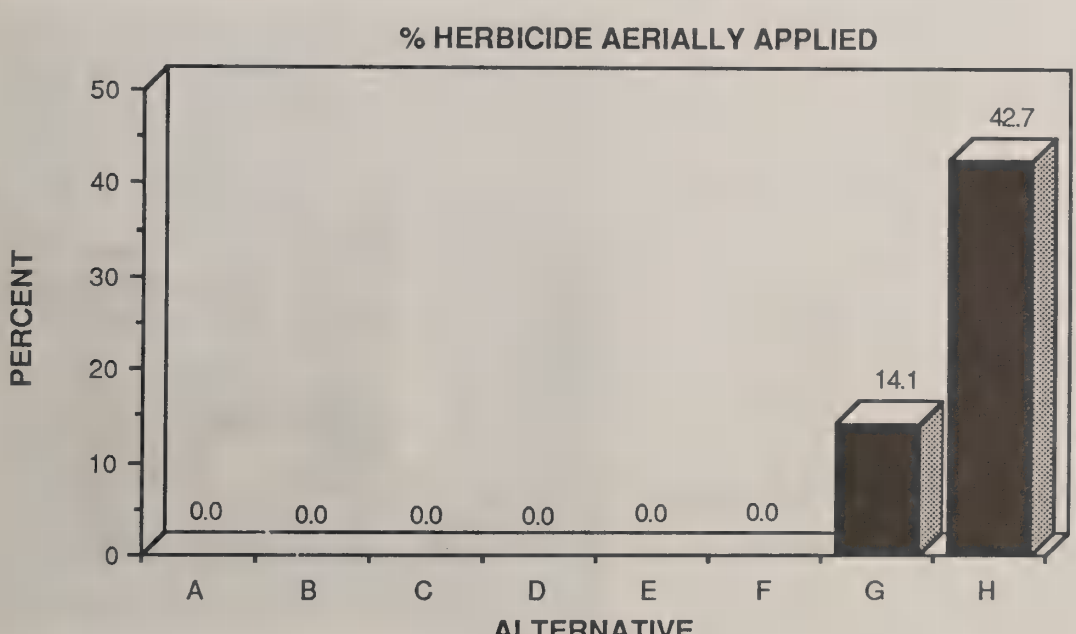


Social Values

Public response becomes negative at the extremes of no treatment or high disturbance tools, and positive with manual methods. Visual values decline with high disturbance tools, but vistas are lost if treatments are excluded. Cultural resources are most damaged by soil-tilling tools like disking and bedding. Alternatives E and G have the greatest advantage because public acceptance becomes positive and risks to visual values and cultural resources are moderate.

Aerial Application

Two alternatives, G and H, include the use of aerial application of herbicides by helicopter. Alternative G treats 7,000 acres (less than .2 percent of the study area). Alternative H treats 28,000 acres (about .6 percent of the study area).



There are **11** issues which led to development of alternatives.

There are **8** alternatives which address the issues.

There are **5** vegetation management methods.

The Risk Assessment evaluates **11** herbicides and **3** additives used in the Forest Service's Southern Region.

The study area covers all or parts of **8** states.

The study area contains **4.6** million acres of national forests and national grasslands.

Vegetation management is currently conducted on about **550,000** acres annually.

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CHAPTER I

Purpose and Need

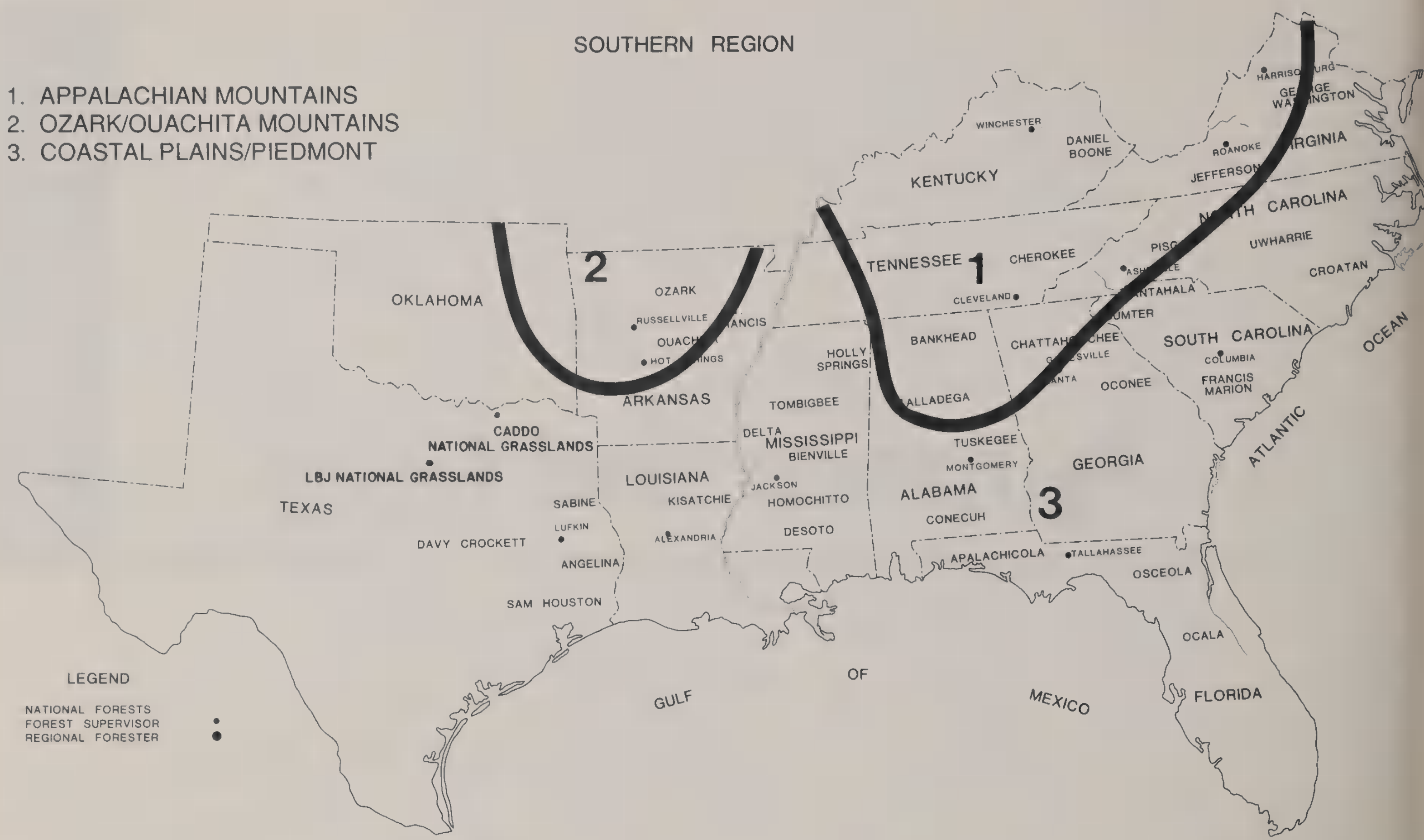
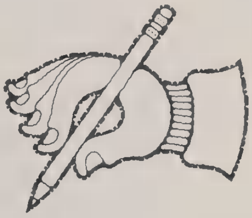


Figure I-1.--Area 3 is the Coastal Plain/Piedmont Area covered by this EIS.

ORGANIZATION OF DOCUMENT

This EIS follows the format recommended by the Council on Environmental Quality. Chapter I, Purpose and Need tells who, what, where, and why about the environmental analysis, and states the issues. Chapter II, Alternatives describes how alternatives were developed, explains which ones are considered, summarizes environmental effects, and identifies the preferred alternative. Chapter III, Affected Environment describes parts of the environment that would affect or be affected by the alternatives. This chapter does not describe effects (see chapter IV). Chapter IV, Environmental Consequences describes environmental impacts of alternatives, including the proposed action. Chapter V is a list of preparers and their experience and qualifications. Chapter VI shows consultations which were made and who received copies of the EIS. Chapter VII is a glossary of terms and acronyms. Chapter VIII contains an index. Chapter IX lists reference materials. Appendices contain specific information on topics too lengthy, technical, or detailed to be included in the text. Readers can quickly grasp important aspects of this EIS by reading the Summary beginning on page i in the preceding section.

Part of the EIS analysis includes a risk assessment, presented in appendix A. A summary of the risk assessment is available from USDA Forest Service, Southern Region, 1720 Peachtree Road, N.W., Atlanta, Georgia 30367.



CHAPTER I

PURPOSE AND NEED

IN BRIEF

Part A tells who prepared this environmental impact statement and what it is about. Part B tells why the statement was prepared. Part C tells what limits are placed on decisions following the analysis and how these decisions relate to this and other environmental documents and plans. Part D is an overview of the public involvement process. Part E contains a complete description of issues addressed. Part F describes some of the social aspects of herbicide-use and briefly describes how and why the risk assessment was prepared.

A. INTRODUCTION

National Forests of the Southern Region are managed to provide a mix of goods and services to the public. Each Forest Land and Resources Management Plan details specific resource management objectives and output goals. These plans provide for access to the national forests, livestock grazing, timber management, visual quality, water quality, and wildlife and fish diversity. To produce these outputs some vegetation management must be done. Different environmental conditions and different objectives and goals determine the need for and amount of vegetation management done.

This Environmental Impact Statement (EIS) prepared by the USDA Forest Service Southern Region documents the results of analysis of methods of vegetation management for:

- Site preparation for reforestation of pines and hardwoods; which is done to reduce plant competition so that pine and hardwood seedlings and saplings get needed amounts of sunlight, water, nutrients, and growing space in order to survive and grow in newly established stands.

- Stand management for timber stand improvement (release, precommercial thinning); which maintains tree growth rates, species composition, adequate stocking, and stand conditions.

- Wildlife habitat improvement, including openings maintenance; which provides a wide variety of plants and habitat conditions beneficial to wildlife, and also protects and enhances habitats of threatened, endangered, proposed, and sensitive plant and animal species.

• Corridor maintenance for roads and trails, utilities, and railroads; which provides safe travelways and protects investments.

• Range forage improvement; which maintains plant species utilized by grazing animals.

• Fuels treatment; which is done to reduce hazardous fuels.

The area analyzed includes national forests and national grasslands of the Coastal Plain/Piedmont physiographic areas of the Southern Region (figure I-1 and table III-1). This EIS was guided by the National Environmental Policy Act of 1969 as amended, Council on Environmental Quality Regulations, and USDA Forest Service implementing procedures (FSM 1950).

Different sets of guidelines are evaluated to determine when and where it is appropriate to use mechanical, prescribed fire, manual, herbicide, or biological methods to control competing vegetation. When projects are proposed, managers will use the selected set of guidelines to decide the most suitable vegetation control methods under specific site conditions. Decisions about suitability of methods will be based on a separate environmental analysis of proposed activities. That analysis will be tiered to this EIS and to the EIS which accompanies the Forest Land and Resource Management Plan.

B. NEED FOR ACTION

As Forest Land and Resource Management Plans are implemented, goals for output of goods and services for the present and future will be established. In many cases achievement of these goals requires vegetation management. The need to prepare an EIS was determined by:

• Management need to evaluate and identify methods and techniques most appropriate to accomplish resource-management goals;

• Public concern and plan appeals questioning adequacy of plan analysis of vegetation management methods and effects;

• New, safer, and less expensive tools, equipment, herbicides, and means for applying vegetation management methods; and

• Recent court decisions that registration of herbicides by the Environmental Protection Agency is not subject to provisions of the National Environmental Policy Act, but that use of herbicides is, particularly regarding risks to human health.

C. SCOPE OF DECISIONS

Analysis in this EIS provides information for policy, program, and site-specific decisions. These decisions cover the range of vegetation management methods and techniques that are most likely to accomplish objectives in Forest Land and Resource Management Plans. In addition, management requirements, mitigation measures, and monitoring needs are identified in chapters II and IV. Finally, the linkage between this EIS and Forest Land and Resource Management Plans and site-specific environmental analyses is discussed here, in chapter II, and in the Record of Decision (when it is prepared).

Alternatives considered in this EIS are programmatic and establish an emphasis and range of vegetation management methods and techniques which will be used to implement Forest Land and Resource Management Plans (plans). Decisions following this EIS consider accomplishing goals and objectives of plans, however amendments may be needed. Upon implementation of the selected alternative, forests will incorporate necessary changes into their plans.

For site-specific projects, decisions about which vegetation management method or technique to use will be based on a separate analysis (chapter II, mitigation measure a., 1.). Choices of methods and tools are limited to those available in the selected alternative. Site-specific project analyses will be tiered to this EIS and to the EIS which supports the Forest Land and Resource Management Plan.

D. PUBLIC INVOLVEMENT

A public involvement summary is in chapter VI. The Notice of Intent to prepare this EIS was published in the September 11, 1986 Federal Register. In January 1987 more than 11,000 interested individuals, groups, and agencies were asked to identify issues to be addressed in this EIS. Concurrently, a press release was distributed Regionwide. About 50 key contacts were also reached by phone or in person. Between January and September 1987, replies were received from 891 respondents. Analysis of this public response identified 11 issues to be addressed. A revised Notice of Intent, based on early scoping results, was published in the May 5, 1987, Federal Register. This revision described methods which would be evaluated and estimated dates of availability of draft statements and final statements. Also, in May 1987, 6,000 information tabloids about issues and alternatives were distributed.

E. ISSUES ADDRESSED

An issue is a subject or question of widespread public interest relating to management of a national forest or grassland. These issues incorporate concerns of the public, employees, and managers.

1. Balance of Resources

Commenters support balanced resource management and believe vegetation management is essential to achieve it. There is, however, widespread belief that vegetation management on treated sites will favor timber production at the expense of wildlife, recreation, ecosystem diversity, soil and water, aesthetics, and cultural resources.

2. Timing, Frequency and Intensity of Prescribed Fire

Commenters prefer prescribed fire over other methods of vegetation management. They view it as a natural process which benefits wildlife and fire-dependent plant communities, is safe and economical, and reduces wildfire hazards. They express mild concern about potential adverse effects on soil, water, and air quality. Season (growing or dormant), intensity, and frequency of burns should be managed to increase benefits and reduce adverse effects. Most people believe the Forest Service has the expertise to use this method effectively.

3. Concern for Human Health and Safety

Most respondents see mechanical, hand, and prescribed fire methods as relatively safe, though they are concerned about effects of burning after herbicide treatment and highway hazards from smoke. These people see herbicides as a

potential threat to the health of the public, including herbicide applicators and forest users who visit treated areas. Many people believe that proper training and supervision of herbicide applicators can reduce health risks. Some people want health and safety risks assessed for all methods so that overall risks can be minimized.

4. Reduced Plant and Animal Diversity

Respondents generally see effects of vegetation management on plant and animal diversity as negative. Moreover, they see combinations of herbicides and mechanical methods as very undesirable. These commenters feel that such combinations completely remove some species from a site. Prescribed fire and hand methods are viewed as more desirable, because they are considered more "natural" and are thought to suppress vegetation temporarily. Concerns about diversity are often linked with concerns about wildlife habitat.

5. Inadequate Communication--Lack of Understanding

Commenters feel the Forest Service poorly communicates the reasons why vegetation management is done and why certain methods and techniques are chosen. Respondents say that they do not understand Forest Service definitions of desirable species, environmental effects, and safety precautions. This perceived lack of communication by the Forest Service creates negative attitudes about herbicides because of suspected but unproven impacts. If they were better informed about effects and planned treatments, many people would support a broader selection of vegetation management tools.

6. Cost Comparison Between Methods

Commenters support vegetation management methods which achieve our objectives with least cost and least unfavorable environmental impact. These people prefer prescribed fire because they believe it offers multiple benefits at small cost. Herbicides are the next most economical method. These commenters also see mechanical methods as costly and providing little employment. Although costs of hand treatments are high, some people prefer them because such treatments provide the most employment and cause the least unfavorable environmental impact.

7. Loss of Long-Term Soil Productivity

Commenters see herbicides, mechanical methods, and prescribed fire as harmful to soil productivity. Their concerns focus on erosion, compaction, rutting, loss of soil micro-organisms, and long-term impact on site productivity.

8. Diminished Surface and Ground Water Quality

Those people responding feel that herbicides are most harmful to drinking water and aquatic communities. The activity, breakdown, and persistence of herbicides in aquatic systems are not well defined scientifically. Pollution of water sources by herbicides is a major

concern. Mechanical methods, and prescribed fire, are considered to have negative effects on water quality. Many believe that if methods are chosen to fit site conditions and proper protection is provided, risks to water quality can be held to acceptable levels.

9. Known and Unknown Effects of Herbicides

There are deep, widespread concerns about potential short- and long-term adverse effects of herbicides on the environment and human health. These concerns are intensified by lack of knowledge about herbicides and lack of trust in study results. There is reluctant willingness to accept herbicide use, provided that stringent safeguards and monitoring are assured. Some people are concerned about effects of specific herbicides and application techniques on non-target organisms.

10. Opportunities for Aerial Application of Herbicides

Public concern has resulted in suspension of aerial application of herbicides. Risks to forest users, adjacent landowners, and forest workers must be evaluated to determine which herbicides may be applied safely, where in the environment they may be applied, and what conditions are necessary to minimize risk. Aerial application of herbicides, in either liquid or granular form, for rights-of-way maintenance and site-preparation for reforestation must be evaluated.

11. Benefits to Wildlife Habitat

Commenters are deeply concerned about wildlife values and strongly support actions which benefit wildlife (game, non-game, and threatened and endangered) species. Herbicides are seen as harmful to wildlife because of suspected direct physical effects, genetic damage, food chain effects, and long-term habitat changes. On the other hand, prescribed fire and hand methods are seen as benefiting wildlife. Some people are concerned that threatened and endangered species or habitat will unknowingly be destroyed regardless of method used.

These issues were used in the formulation, evaluation, and selection of alternatives (chapter II). The effects of the alternatives on issues are identified and these effects are considered when identifying the preferred alternative.

12. Unrelated Comments

Several comments were received on a wide range of issues either not related to this project or beyond its scope. These comments, though meaningful, are not incorporated in the issue statements. Some categories of comments which won't be addressed are silvicultural systems, harvest cutting methods, off-road vehicles, littering, road construction, wilderness designation, military uses, minerals, forest signs, landscape-wide diversity, illegal activities, southern pine beetle, beavers, or multiple-use in a general landscape-wide sense.

Most of these are considered unrelated issues because they have been analyzed and addressed in Forest Land and Resource Management Plans. For example, each plan discusses which silvicultural system and associated harvest cutting methods are appropriate, and where they are to be used, based on each forest's unique mixture of forest resources and public needs. This EIS does not reanalyze those issues resolved by plans, but does evaluate the most efficient, effective, and safe means of vegetation management for the items listed on page I-1.

F. ABOUT HERBICIDES

This EIS analyzes several methods of vegetation management, but herbicide use is a focal point. Issues about herbicides are both scientific and emotional. The public seems to distrust those forest managers who use herbicides. The respondents to our inquiry expressed fear of adverse health effects, including cancer. And, indeed, there is some scientific uncertainly about long-term effects of many herbicides. People commonly ask questions like, "Do these herbicides cause cancer or birth defects?" "What are the short-term and long-term effects of exposure to herbicides?" and "How do they affect wildlife and other aspects of the environment?"

These questions are discussed in the risk assessment in appendix A. It documents an exhaustive study of the most up-to-date data on herbicides (and materials mixed with them for application) proposed for use in the Southern Region. This risk assessment presents information on toxicity for each herbicide, evaluates the possibilities for humans or other animals to be exposed to the herbicides, and then estimates the risk of harmful effects for those toxic properties and exposures. The estimates of risk take into account scientific uncertainty and account for differences in individual sensitivities by incorporating safety factors. The risk assessment discloses the modeling process.

Discussion of herbicide effects in chapter IV and mitigation measures in chapter II are based on the scientific findings of the risk assessment.

Alternatives

CHAPTER II

CHAPTER II

ALTERNATIVES

IN BRIEF

Part A discusses how alternatives were developed. Part B describes each alternative, including methods, tools available, average treatment frequencies, and estimated acres treated. Part C lists alternatives considered but eliminated from detailed study. Part D defines each method and tool and explains how they are used. Part E describes how resources are managed and what actions are taken to lessen adverse impacts or to enhance beneficial effects. Parts F through H compare how the alternatives respond to issues and affect the environment.

A. ALTERNATIVE DEVELOPMENT PROCESS

Several alternatives were developed to respond to issues (Chapter I) and cover a broad range of possible mixes of vegetation management methods. Issues were based on public comments received in early 1987 and on management concerns. Themes were developed to respond to these issues and were shared with the public in May 1987. In June 1987, an interdisciplinary team considered additional public comment and determined the mix of methods appropriate to each theme. Finally, the team compared mixes of methods to find similarities, combined where appropriate, and wrote alternative statements.

Each alternative conforms to the following guidelines:

1. Considers the goals, objectives, and decisions of Forest Land and Resource Management Plans;

2. Should not be constrained by funding;

3. Responds to issues (Chapter I);

4. Should be reasonable and implementable;

5. Conforms to Federal laws and regulations (unless the alternative contemplates a specific change in laws or regulations).

B. ALTERNATIVES CONSIDERED IN DETAIL

In this section each alternative is described to give the reader a sense of how much vegetation management occurs, with what methods and tools, and at what intensity and frequency. First, the underlying theme or intent of the alternative is stated. Second, the vegetation management methods in the alternative are described. Third, the average frequency of activities that recur every few years

(fuel reduction, wildlife and range habitat, corridor maintenance) is presented based on reported field data. Frequencies for site preparation and timber stand improvement are not shown because they are not done on established cycles and usually occur only once per stand rotation. Finally, average acres treated per year by each method are estimated. These acres are only projections used to evaluate environmental effects quantitatively. During implementation, the actual program may vary from these projections.

1. Alternative A (No Action)

Theme

In this, the "no action" alternative, vegetation management is not done. Existing vegetation is allowed to grow without manipulation.

Method

No treatments of any kind are allowed.

Frequency

None.

Estimated Program

Method	Projected Acres/Yr	Percent Total Acres Treated
Herbicides	0	0
Mechanical	0	0
Fire	0	0
Manual	0	0
Biological	0	0
	0	0

2. Alternative B

Theme

Vegetation management is done only to protect forest and grassland resources and public health and safety. Activities are limited to hazardous fuel reduction, corridor maintenance, and protection of threatened and endangered (T&E) species. Total acres treated per year make up about 3 percent of National Forest System lands in the Coastal Plain/Piedmont.

Fuel treatment occurs only when wildfire threat is imminent in high risk areas. Corridor maintenance occurs only when vegetation interferes with utility lines or threatens safe use of roads and trails. Habitat management for T&E species maintains current populations but does not achieve population recovery.

Method

Herbicides: Those with minimal environmental and health risks are applied by hand-ground techniques only. Tools

include backpack sprayers, spotguns, hypo-hatchets, injectors, and axe and sprayer.

Mechanical: Machine treatments are limited to techniques causing low soil disturbance. Because activities are so limited, only mowing is appropriate.

Prescribed Fire: Such fires are limited to low-intensity, dormant season burns (except where growing season burns are needed to maintain T&E species). Timing and location of burns are restricted. Ground and aerial ignition tools are allowed.

Manual: Use of manual labor is minor. Crews use hand tools (axes, blades, clippers) and power tools (chain saws, brush cutters).

Biological: Such treatments are not used.

Frequency

Average Treatment Frequencies

Management Activity	Years
Hazardous fuels - Coastal Plain	5
- Piedmont	7
Threatened & Endangered Species Habitat	3
Other Wildlife Habitat - Coastal Plain	None
- Piedmont	None
Range Habitat	None
Trails	5
Roads - Forest Service	8
- Other	3
Utility Lines	10
Railroads	3
Pipelines	4

Estimated Program

Method	Projected Acres/Yr	Percent Total Acres Treated
Herbicides	3,500	2.7
Mechanical	12,500	9.5
Fire	113,500	87.0
Manual	1,000	0.8
Biological	0	0
	130,500	100.0

3. Alternative C

Theme

Vegetation management is restricted to methods that achieve selective (target-specific) control or cause limited site disturbance. Total acres treated per year make up about 9 percent of National Forest System lands in the Coastal Plain/Piedmont.

Fuel treatment occurs only when fuel loads approach dangerous levels. Corridor maintenance occurs when vegetation approaches utility lines or threatens safety or investments on roads and trails. Wildlife and range treatments occur only when habitat conditions seriously limit populations. Site preparation or timber stand improvement are done only if needed to achieve minimum stocking.

Method

Herbicides: Those with minimal environmental and health risks are applied using hand-ground techniques only. Tools include backpack sprayers, spotguns, hypo-hatchets, injectors, and axe and sprayer.

Mechanical: Machine techniques are limited to those causing low soil disturbance (mowing, chopping, scarifying, ripping, shearing).

Prescribed Fire: Fires are limited to low-intensity, dormant and (to a lesser extent) growing season burns. Timing and location of burns are restricted. Ground and aerial ignition tools are allowed.

Manual: Manual labor is increased from present levels. Hand tools (axes, blades, clippers) and power tools (chain saws, brush cutters) are used.

Biological: Livestock grazing to control vegetation is minor.

Frequency

Average Treatment Frequencies

Management Activity	Years
Hazardous fuels - Coastal Plain	5
- Piedmont	7
Threatened & Endangered Species Habitat	2
Other Wildlife Habitat - Coastal Plain	5
- Piedmont	7
Range Habitat	5
Trails	3
Roads - Forest Service	4
- Other	2
Utility Lines	8
Railroads	2
Pipelines	3

Estimated Program

Method	Projected Acres/Yr	Percent Total Acres Treated
Herbicides	17,000	4.1
Mechanical	35,500	8.6
Fire	355,000	85.6
Manual	6,500	1.6
Biological	500	0.1
	414,500	100.0

4. Alternative D

Theme

Herbicides are not used. Total acres treated per year make up about 12 percent of National Forest System lands in the Coastal Plain/Piedmont.

Method

Herbicides: Herbicides are not used.

Mechanical: Treatments are increased from present levels, but limited to techniques causing low to moderate soil disturbance (mowing, chopping, scarifying, ripping, shearing, piling, bedding, light disking).

Prescribed Fire: Controlled fires are increased from present levels, but limited to low to moderate intensity, dormant and growing season burns. Ground and aerial ignition tools are allowed.

Manual: Manual labor techniques are increased from present levels. Hand tools (axes, blades, clippers) and power tools (chain saws, brush cutters) are used.

Biological: Biological grazing to control vegetation is moderate.

Frequency

Average Treatment Frequencies

Management Activity	Years
Hazardous fuels - Coastal Plain	4
- Piedmont	6
Threatened & Endangered Species Habitat	2
Other Wildlife Habitat - Coastal Plain	4
- Piedmont	6
Range Habitat	3
Trails	1
Roads - Forest Service	3
- Other	1
Utility Lines	6
Railroads	1
Pipelines	2

Estimated Program

Method	Projected Acres/Yr	Percent Total Acres Treated
Herbicides	0	0
Mechanical	70,500	12.7
Fire	464,000	83.8
Manual	18,000	3.3
Biological	1,000	0.2
	553,500	100.0

5. Alternative E

Theme	Manual methods and prescribed fire are the major means of vegetation control. Total acres treated per year make up about 12 percent of National Forest System lands in the Coastal Plain/Piedmont.

Method

Herbicides: Herbicide use is reduced from present levels. Those with minimal environmental and health risks are applied using hand-ground and mechanical-ground techniques. Hand tools include backpack sprayers, spotguns, hypo-hatchets, injectors, and axe and sprayer. Mechanical tools include boom sprayers and granular spreaders.

Mechanical: Machine use is reduced from present levels, limited to techniques causing low to moderate soil disturbance (mowing, chopping, scarifying, shearing, ripping, piling, bedding, light disking).

Prescribed Fire: Use of fire is increased from present levels, but limited to low to moderate intensity, dormant and growing season burns. Ground and aerial ignition tools are allowed.

Manual: Manual labor is increased from present levels. Hand tools (axes, blades, clippers) and power tools (chain saws, brush cutters) are used.

Biological: Livestock grazing to control vegetation is moderate.

Frequency

Average Treatment Frequencies

Management Activity	Years
Hazardous fuels - Coastal Plain	4
- Piedmont	6
Threatened & Endangered Species Habitat	2
Other Wildlife Habitat - Coastal Plain	4
- Piedmont	6
Range Habitat	3
Trails	1
Roads - Forest Service	3
- Other	1
Utility Lines	6
Railroads	1
Pipelines	2

Estimated Program	Method	Projected Acres/Yr	Percent Total Acres Treated
	Herbicides	11,500	2.0
	Mechanical	35,000	6.3
	Fire	472,000	85.3
	Manual	33,500	6.1
	Biological	1,500	0.3
		553,500	100.0

6. Alternative F

Theme

This alternative continues present levels of treatment specified in the Forest Land and Resource Management Plans. Total acres treated per year make up about 12 percent of National Forest System lands in the Coastal Plain/Piedmont.

Method

Herbicides: Treatments are applied using hand-ground and mechanical-ground techniques. Hand tools include backpack sprayers, spotguns, hypo-hatchets, injectors, and axe and sprayer. Mechanical tools include boom sprayers and granular spreaders.

Mechanical: Techniques causing low to high soil disturbance are allowed (mowing, chopping, scarifying, ripping, shearing, piling, bedding, light and heavy disking, raking).

Prescribed Fire: Low to high intensity, dormant and growing season burns are used. Ground and aerial ignition tools are allowed.

Manual: Manual labor is used in moderate amounts. Hand tools (axes, blades, clippers) and power tools (chain saws, brush cutters) are used.

Biological: Such control of vegetation is not used.

Frequency

Average Treatment Frequencies

Management Activity	Years
Hazardous fuels - Coastal Plain	4
- Piedmont	6
Threatened & Endangered Species Habitat	2
Other Wildlife Habitat - Coastal Plain	4
- Piedmont	6
Range Habitat	3
Trails	1
Roads - Forest Service	3
- Other	1
Utility Lines	6
Railroads	1
Pipelines	2

Estimated Program	Method	Projected Acres/Yr	Percent Total Acres Treated
	Herbicides	27,000	4.9
	Mechanical	59,000	10.7
	Fire	463,000	83.6
	Manual	4,500	0.8
	Biological	0	0
		553,500	100.0

7. **Alternative C**

Theme

Prescribed fire and herbicides are the major means of vegetation control. Total acres treated per year make up about 12 percent of National Forest System lands in the Coastal Plain/Piedmont.

Method

Herbicides: Use is increased from present levels. Those with minimal environmental and health risks are applied using hand-ground, mechanical-ground, and aerial techniques. Hand tools include backpack sprayers, spotguns, hypo-hatchets, injectors, and axe and sprayer. Mechanical tools include boom sprayers and granular spreaders. Aerial tools are limited to helicopters. Selective treatments are favored over broadcast treatments.

Mechanical: Use of machines is reduced from present levels and limited to techniques causing only low to moderate soil disturbance (mowing, chopping, scarifying, ripping, shearing, piling, bedding, light disking).

Prescribed Fire: Fire use is limited to low to moderate intensity, dormant and growing season burns. Ground and aerial ignition tools are allowed.

Manual: Manual labor is maintained at about present levels. Hand tools (axes, blades, clippers) and power tools (chain saws, brush cutters) are used.

Biological: Livestock grazing to control vegetation is minor.

Frequency

Average Treatment Frequencies

Management Activity	Years
Hazardous fuels - Coastal Plain	4
- Piedmont	6
Threatened & Endangered Species Habitat	2
Other Wildlife Habitat - Coastal Plain	4
- Piedmont	6
Range Habitat	3
Trails	1
Roads - Forest Service	3
- Other	1
Utility Lines	6
Railroads	1
Pipelines	2

Estimated Program

Method	Projected Acres/Yr	Percent Total Acres Treated
Herbicides (ground)	42,500	7.7
Herbicides (aerial)	7,000	1.2
Mechanical	32,000	5.8
Fire	466,500	84.3
Manual	5,000	0.9
Biological	500	0.1
	553,500	100.0

8. Alternative [redacted]

Theme

Vegetation management is done to achieve maximum vegetation control within legal constraints. Total acres treated per year make up about 17 percent of National Forest System lands in the Coastal Plain/Piedmont.

Herbicides are broadcast at maximum effective rates, intensive mechanical techniques are practiced, and intense prescribed fires are used more frequently than at present. Repeat entries occur on highly productive lands where competition and return on investment are greatest.

Method

Herbicides: This treatment is increased from present levels, applied using hand-ground, mechanical-ground, and aerial techniques. Hand tools include backpack sprayers, spotguns, hypo-hatchets, injectors, and axe and sprayer. Mechanical tools include boom sprayers and granular spreaders. Aerial tools are limited to helicopters. Where feasible, herbicides are broadcast at the maximum effective rates permitted by product label.

Mechanical: Use of machinery is increased from present levels. Techniques causing low to high soil disturbance are allowed (mowing, chopping, scarifying, ripping, shearing, bedding, piling, light and heavy disking, raking).

Prescribed Fire: Fire use is increased from present levels. Higher intensity, dormant and growing season burns are used. Ground and aerial ignition tools are allowed.

Manual: Manual labor is reduced from present levels and used only where it achieves desired vegetation control. Hand tools (axes, blades, clippers) and power tools (chain saws, brush cutters) are used.

Biological: Livestock grazing to control vegetation is used aggressively.

Frequency

Average Treatment Frequencies

Management Activity	Years
Hazardous fuels - Coastal Plain	3
- Piedmont	5
Threatened & Endangered Species Habitat	2
Other Wildlife Habitat - Coastal Plain	3
- Piedmont	5
Range Habitat	2
Trails	1
Roads - Forest Service	2
- Other	1
Utility Lines	3
Railroads	1
Pipelines	1

Estimated Program

Method	Projected Acres/Yr	Percent Total Acres Treated
Herbicides (ground)	37,500	4.7
Herbicides (aerial)	28,000	3.5
Mechanical	64,500	8.1
Fire	667,000	83.3
Manual	1,500	0.2
Biological	2,500	0.3
	801,000	100.0

C. ALTERNATIVES CONSIDERED, BUT ELIMINATED FROM DETAILED STUDY

Full Vegetation Control With No Constraints: This alternative allows for complete vegetation control without regard for floodplains and wetlands, threatened and endangered species, cultural resources, wilderness values, and other mandated constraints.

It was eliminated from detailed study because the little added competition control gained by violating laws and regulations that protect vital resources was not deemed reasonable or implementable.

No Prescribed Fire: This alternative eliminates the use of prescribed fire. Use of other methods, particularly mechanical and herbicide, increases to fill the void.

This alternative was eliminated because issues that address prescribed fire generally debate its intensity, timing, and frequency but support its use.

D. DESCRIPTION OF METHODS AND TOOLS

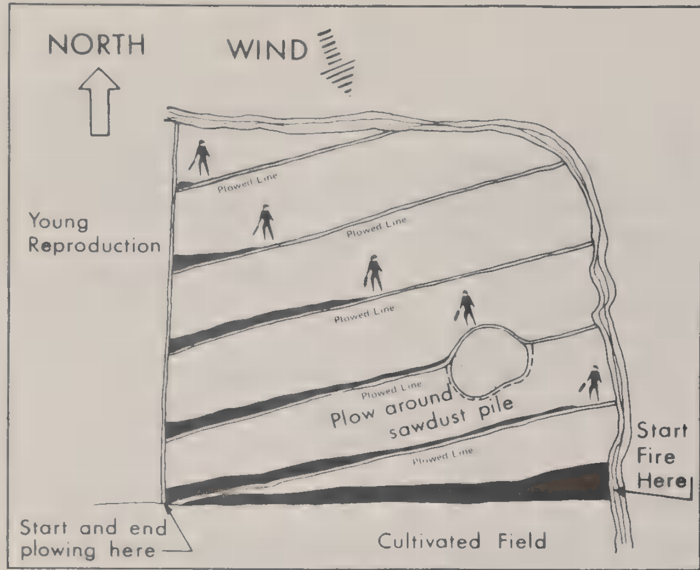
This section describes methods and tools proposed for use in the vegetation management program. Methods discussed are prescribed fire, mechanical, manual, herbicides, and biological. Regardless of the harvest cutting methods identified in Forest Land and Resource Management Plans, all of the tools described in this section are available for use as specified by each alternative.

1. Prescribed Fire Methods

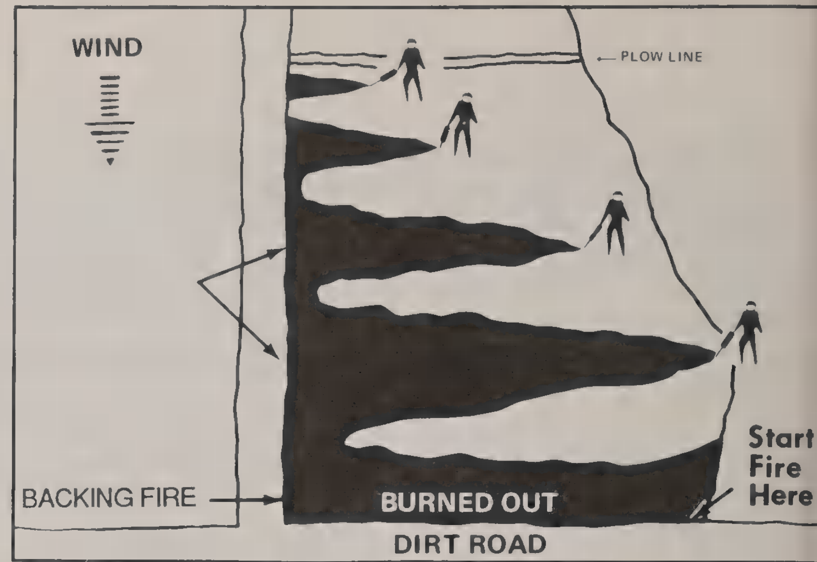
Prescribed fire is the planned use of fire under specific site conditions to achieve specific project objectives. It is used to reduce hazardous fuels, prepare sites for seeding or planting, rejuvenate wildlife and range forage species, maintain fire-dependent species and ecosystems, control insects and diseases, and manage wilderness and threatened and endangered species and their habitat. Factors evaluated when using prescribed fire include project objectives, fuels (quantity, type, distribution, moisture content), topography (ruggedness, elevation, slope), weather (temperature, wind, humidity), time of year, smoke dispersal, and predicted fire behavior (flame length, rate of spread).

Light to moderate burns that retain effective litter cover cause little site damage. Severe burns that consume litter to mineral soil on a large portion of an area create high risks of soil erosion and loss of soil organisms, soil structure, organic matter, and nutrients.

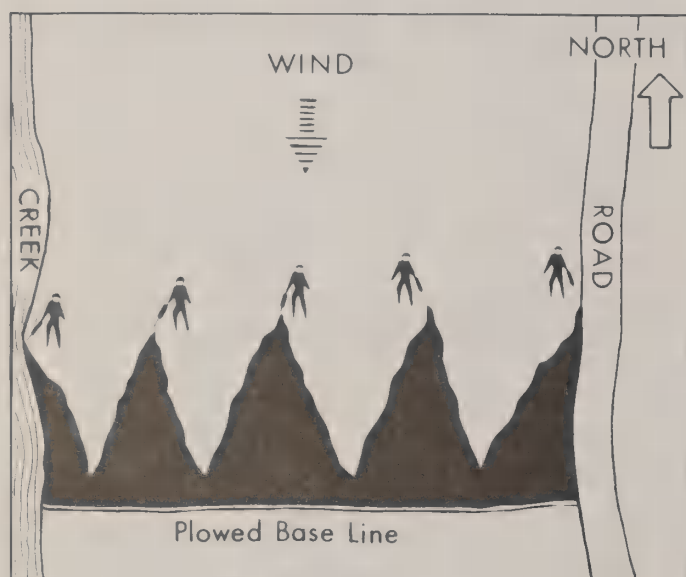
Firing techniques are the patterns used to dispense fire. The six techniques commonly used are backing fires, strip-head fires, flanking fires, spot fires, ring fires, and slash pile or windrow fires (figure II-1).



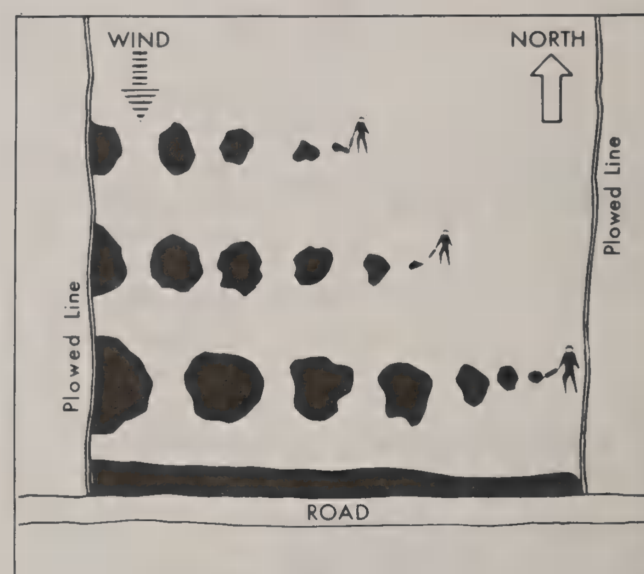
BACKING FIRE TECHNIQUE



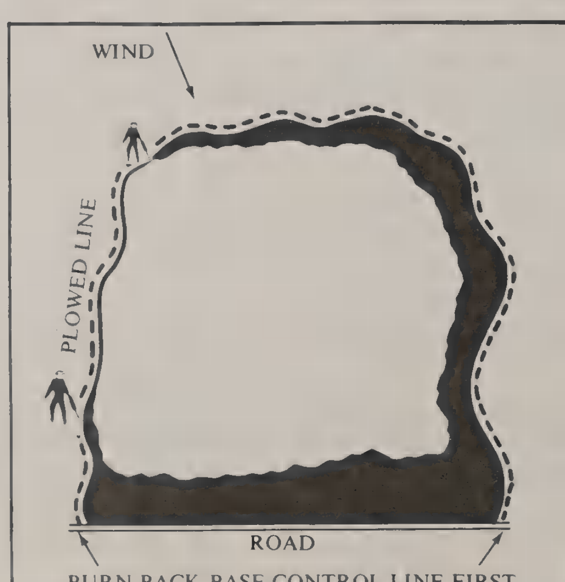
STRIP-HEAD FIRE TECHNIQUE



FLANK FIRE TECHNIQUE



SPOT FIRE TECHNIQUE



RING FIRE TECHNIQUE

Figure II-1.--Firing techniques.

Backing fires consist of backing a fire against the wind. Strip-head fires are a series of parallel lines of fire set against the wind, perpendicular to wind direction; lines burn with the wind but never gain momentum before burning into the next line. Flanking fires are a series of lines of fire set against the wind, parallel to wind direction, that burn out at right angles from the wind direction. Spot fires are a series of parallel fire spots (approximately 50 to 250 feet apart) set against the wind. The fires radiate out in all directions, minimizing fire momentum as they burn together. Ring fires are the application of a single line of fire completely around a burn area. Slash pile or windrow fires are applied to concentrated fuel piles.

Three types of ignition tools are commonly used in the Coastal Plain/Piedmont. The traditional ground based system is the hand-held driptorch. The other two tools, which are aerial ignition systems, are the helitorch and plastic sphere dispenser. Choice of firing technique and ignition tool depends on project objectives and site conditions.

a. Hand-held Driptorch

Driptorches are small hand-held aluminum or stainless steel tanks that contain a mixture of gasoline and diesel fuel. A spout attached to the tank drips the fuel mixture onto a lighted wick. Lighted fuel falls to the ground igniting surface fuels. All six firing techniques can be applied using hand-held driptorches.

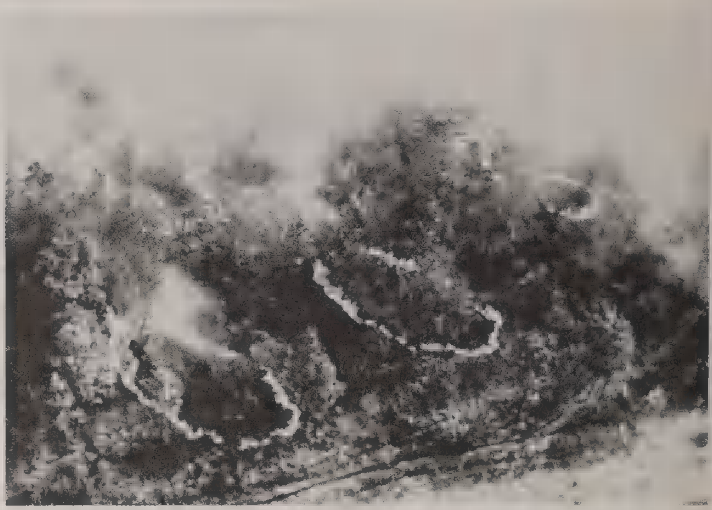
b. Helitorch

Helitorches are specially designed driptorches for application of ignited gelled fuel from helicopters. They consist of a 30 or 50 gallon fuel drum, an ignition and electric pump assembly, and frame and suspension system. The helitorch is suspended laterally beneath and to the front of a helicopter with the nozzle end of the torch positioned on the same side as the pilot. The pilot controls flow and ignition of the gelled fuel. Gelled fuel is formed by adding a fuel thickening powder to either regular gasoline or a 70-30 mixture of diesel fuel and gasoline. The strip-firing technique is most commonly used, although all firing techniques can be applied using a helitorch.

c. Plastic Sphere Dispenser

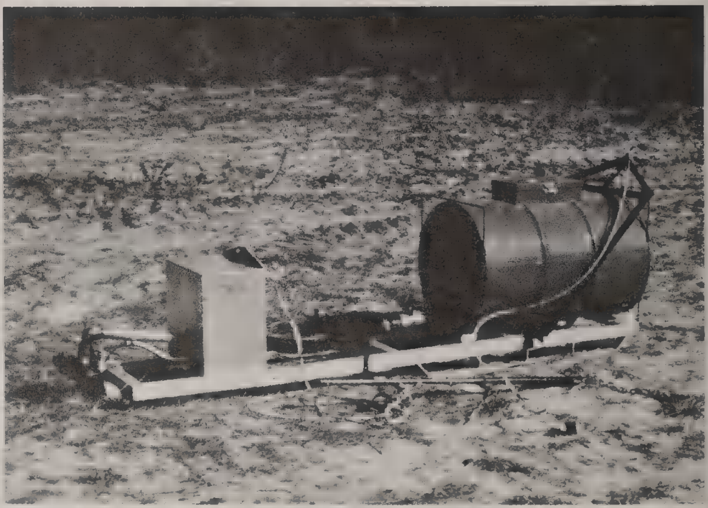
The plastic sphere dispenser is also applied using helicopters but the tool is mounted just inside the side door of a helicopter. The device ejects small spheres (commonly called "ping-pong balls"), made of high-impact polystyrene, approximately 1.25 inches in diameter, and filled with 3 grams of potassium permanganate (a dark purple salt used as an oxidizer). Immediately prior to ejection, the spheres are injected with about 1 milliliter of ethylene glycol (antifreeze). Spheres are dropped onto the treatment area at predetermined spacings (one or more per acre). After a delay of approximately 20 seconds, a reaction between the two chemicals ignites the sphere and subsequently surface fuels. The spot-firing technique is applied when using the plastic sphere dispenser.

Aerial Ignition Device



Spot firing technique

Helitorch in operation



Helitorch

Hand held drip torch

Helitorch

2. Mechanical Methods

Nine types of mechanical tools are commonly used on national forests in the Coastal Plain/Piedmont. They are divided into three categories based on their potential for soil disturbance by erosion, compaction, and nutrient loss. Potential soil disturbance is low for mowing, chopping, shearing, scarifying, and ripping tools; moderate for piling and bedding tools; and high for raking and disking tools.

a. Mowing Tools

Mowing tools are rotary cutting devices that cut, chop, or shred vegetation on slopes up to 30 percent. Herbaceous species (grasses, grass-likes, forbs) as well as woody species (vines, shrubs, trees) are cut near the ground line and are effectively mulched and scattered, facilitating on-site decomposition and nutrient cycling. These tools are most effective on vegetation 3 inches or less in diameter. They are commonly used to maintain road and utility rights-of-way, refurbish wildlife food plots, and precommercially thin young stands. Since mowing tools cut vegetation above the ground line, soil is little disturbed.

Sprouting species require repeated treatments because they rapidly recover and compete with desirable vegetation. In addition, as the material is cut it can be ejected out from the machine causing a safety hazard to workers or bystanders.

b. Chopping Tools

Two types of chopping tools are used. The most common are single or tandem rolling drum choppers towed by a crawler tractor. They cut and chop herbaceous and woody vegetation up to 5 inches in diameter and operate on slopes up to 35 percent. Vegetation is pushed to the ground and cut into small pieces as the chopper rolls over it. The other type of chopper is a larger, heavier, self-propelled model that will push over trees up to 40 inches in diameter and chop material up to 10 inches in diameter. Chopping tools are used mainly for site preparation. Minor use occurs for rights-of-way maintenance and precommercial thinning.

Vegetation is cut and chopped into small pieces, which facilitates decomposition and nutrient cycling. Depressions made by chopping blades also increase water infiltration and incorporation of organic matter into the soil. Soil exposure and disturbance are minor.

Release treatments may be needed because of rapid recovery of sprouting species, and debris left in place may impair planting. Soil exposure can be significant at the upper end of the tools' slope range.

c. Shearing Tools

Shearing tools are specialized cutting blades mounted on crawler tractors. The two types used are K-G ("angle") blades and V-blades. They are used on slopes up to 35 percent. Any size of herbaceous and woody vegetation can be cut just above the ground line. This equipment is used for site preparation and provides a cleared area ready for direct seeding or planting.

As material is pushed aside, topsoil can be displaced, which increases risk of erosion. Sprouting species recover quickly and compete with desired vegetation.

d. Scarifying Tools

Scarifying tools clear herbaceous and small woody vegetation; their rotating scalping blades form a shallow depression, 2-4 inches deep, with an adjacent pile of topsoil. The modified area is approximately 18 inches by 3 feet in size. Size and spacing of scalped areas can be varied. On the average, cleared areas are on a 7-foot by 7-foot spacing. Scarifiers are usually towed behind a crawler tractor or rubber-tired skidder on slopes up to 35 percent. They are used mainly for site preparation.

Scarifiers modify soil moisture and nutrient conditions. Depressions increase water storage, and adjacent piles have increased soil drainage and concentrated nutrients. Cleared areas are not continuous and ground cover between them is normally not disturbed, so risk of erosion and nutrient loss is very low.

Efficiency of scarifiers is reduced on steep slopes, shallow soils, and sites having many obstacles such as large rocks, stumps, or logs. Additional treatments, such as herbicide placement alongside scalped areas or subsequent release after seeding or planting, may be necessary on sites with abundant understory vegetation to reduce competition around cleared areas.

e. Ripping Tools

Ripping tools (also called subsoilers or chisel plows) are large blades or shanks pulled through the soil at depths of 4 to 20 inches. Spacing between rips varies from 3 to 12 feet. The exposed soil ranges from 6 to 24 inches wide. Because of the blades' size and tilling depth, rippers are usually mounted on or pulled behind large farm or crawler tractors. Ripping is normally done on the contour on slopes up to 35 percent. Rips placed on the contour can be continuous, but rips not on the contour are broken up by lifting the blades out of the ground every 50 to 100 feet. Some wildlife and range habitat improvement projects use rippers, but they are mainly used for natural or artificial site preparation.

Rippers break up and mix compacted soils and improve soil porosity. This action forms a microsite more suitable for seeding or planting by improving soil drainage and available moisture. Risks of erosion are very low when done on the contour, but increase when done up and down steeper slopes.

High amounts of logging slash or woody understory vegetation reduce ripping efficiency. Treatments such as prescribed burning or shearing and piling prior to ripping may be necessary on such sites to facilitate ripping.

Mowing tool - Shredder

Mowing tool - Hydro Axe

Mowing tool - Bush-hog

Ripping tool

Scarifying tool

Tandem rolling drum choppers

f. Piling Tools

Piling tools move logging slash and woody understory vegetation into piles or windrows. The piling tool is commonly called a brush rake or piling and stacking rake. It replaces the dozer blade on a crawler tractor and is used on slopes up to 35 percent. It is not solid like a standard dozer blade, but consists of a series of curved teeth spaced at intervals of 6 to 24 inches. The rake is held above the soil surface, and logging slash and brush are rolled forward into piles or windrows. Piling tools are used mainly for preparing sites for artificial regeneration.

Teeth of the rake do not penetrate the soil and are curved to produce a rolling motion of material being piled, which creates a moderate amount of soil disturbance. As the material is rolled forward, nearly all topsoil and much litter filter through the spacings between the rake teeth.

g. Raking Tools

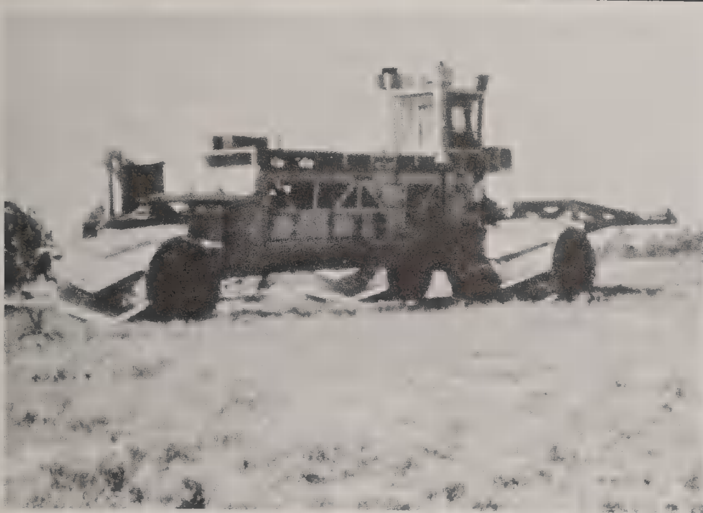
Raking tools also move logging slash and woody understory vegetation into piles or windrows. Rakes are standard dozer blades or brush rakes mounted on a crawler tractor. They can operate on slopes up to 35 percent. Raking tools are used mainly for preparing sites for artificial regeneration.

Raking differs from piling. When using a standard, solid dozer blade, the material is pushed forward with little rolling action. This action causes logging slash, brush, litter, and some topsoil to be scraped into the piles or windrows. When using a brush rake, the teeth are lowered to penetrate the soil, uprooting and pushing herbaceous and small woody vegetation ("root-raking") as well as litter and some topsoil along with the logging slash and brush into the piles. Soil disturbance by raking is high.

h. Bedding Tools

Bedding tools plow, mix, and loosely pile topsoil and litter into elevated beds. Bedding is normally done on wet sites having slopes of 3 percent or less. Bedding tools consist of one or more sets of disks pulled by a crawler tractor. The disks plow toward each other, piling topsoil and litter into a bed. Some bedding tools utilize choppers or rollers behind the plowing disks to enhance bed settling and shaping. Beds range from 6 to 8 feet wide and from 12 to 18 inches high. After soil settling, bed heights range from 8 to 15 inches. Bedding tools are used for preparing sites for artificial regeneration. Prior to using bedding tools, treatments such as shearing, piling, or raking are commonly used to remove logging slash or brush.

Mixing of topsoil and litter concentrates nutrients in the beds. In level wet areas, the small increase in elevation greatly improves soil drainage. Root systems of seedlings planted in beds become established in unsaturated soil, which improves seedling survival and growth rates.



Self propelled chopper

Disking tool

Bedding tool with bed settling attachment

Bedding tool with a bed shaping attachment

Shearing tool, V-blade

Piling tool - brush rake

Soil disturbance from bedding is moderate. Although soil exposure is high, erosion or nutrient loss from the site is low due to the flat terrain. Bedding can be used to break up compacted surface soils.

i. Disking Tools

Disking tools consist of one or more sets of disks pulled behind a farm or crawler tractor. Disks plow by tilling and mixing topsoil and litter to depths of 4 to 20 inches. Disking is usually done on the contour on slopes up to 30 percent. Disking tools are used for wildlife and range habitat maintenance and for preparing sites for artificial regeneration.

Disking is divided into light and heavy categories based on intensity of tilling. Light disking is done to shallow depths on small areas (usually less than 1 acre), in strips, or on slopes of 5 percent or less. Undisked strips act as filter strips that reduce soil loss. Examples of light disking are wildlife opening refurbishment and reseeding of logging roads and skid trails. Heavy disking is commonly done to greater depths over large areas at slopes steeper than 5 percent. Many site-preparation areas and range refurbishment projects feature heavy disking.

Efficiency of disking is reduced on areas with many obstacles that could damage disks, such as large rocks, logs, or stumps. On areas with heavy logging slash or abundant brush, common treatments prior to disking include shearing, piling, or raking. Disking can break up compacted surface soils.

3. Manual Methods

Manual methods utilize hand-operated powered or non-powered tools to cut, clear, thin, or prune herbaceous and woody species. Non-powered hand tools are axes, brush hooks, and hand clippers. Powered hand tools include chainsaws and motorized brushcutters (weed eaters with a saw-type blade). Slope does not limit use of manual tools in the Coastal Plain/Piedmont. Manual tools are most commonly used for timber stand improvement (release, precommercial thinning), corridor maintenance (especially trails), wildlife and range habitat improvement, and threatened and endangered species habitat improvement projects.

Manual cutting tools sever vegetation above the ground line; soil is seldom exposed. Residues are usually left intact on the treatment area, facilitating nutrient cycling as the materials slowly decompose. Heavy amounts of slash may initially cause an increase in fire hazard. Sprouting species rapidly recover and compete with desirable vegetation, requiring repeated manual treatments or the use of other treatments such as herbicides or prescribed fire.


Cattle as a biological control tool


Powered hand tool - chainsaw


Brush axes


Brush hook


Brushsaw


Cattle as a biological control tool

4. Herbicide Methods

Characteristics of the 11 herbicides used in the Southern Region are described, as are 3 application methods: (1) manual ground, which requires hand-carried equipment; (2) mechanical ground, which requires truck or tractor mounted equipment; and (3) aerial, which requires helicopter mounted equipment.

Herbicides currently are applied as either liquid sprays or solid granules. All spray-application tools are designed to produce large droplets to minimize drift. The relatively large and heavy granules are designed to minimize drift.

a. Herbicides Characteristics

New herbicides and application methods are periodically registered for silvicultural use.

Prior to operational use, efficacy of the product is evaluated through research and administrative studies on restricted areas. If the product is effective, an amendment is prepared which includes a toxicological background statement, a risk assessment, and analysis of its environmental behavior. Once testing, documentation, and public disclosure of findings are complete, field personnel are notified of the availability of the new herbicide or tool.

<u>DICAMBA</u>

TRADE NAME: BANVEL^{R}, BANVEL^{R} CST, BANVEL^{R} 720, and others.

Dicamba is regularly used for broadleaf weed control in food crops including small grains, corn, sorghum, sugarcane and asparagus. Additionally, it has labeled uses for weed control in turfgrass and utility rights-of-way. In forestry, its labeled use is for woody plant control in site preparation. In the South, dicamba is not widely used in forestry work. Methods of application include cut-surface treatments, basal spray, and foliar spray. Dicamba is readily absorbed and translocated by the roots, stems, and foliage of plants. In susceptible species, dicamba acts primarily as a growth regulator affecting shoot and root development. The degree of effect varies by species. Dicamba may be broken down by the plant or moved through the roots to surrounding soil. Dicamba may move in the soil, especially sandy soils. Micro-organisms biodegrade dicamba in soil. It persists in the soil from 3 to 12 weeks depending on weather.

<u>FOSAMINE</u>

TRADE NAME: KRENITE^{R}, KRENITE^{R} S.

Fosamine ammonium is labeled for use on non-cropland brush control along railroads, rights-of-way, industrial plant

sites, drainage ditch banks, etc., including lands adjacent to and surrounding domestic water supply reservoirs. In forestry it is seldom used, but is used for rights-of-way maintenance. Method of application is foliar spray and coverage must be complete to be effective. Fosamine is absorbed by foliage, stems, and buds of broad leafed plants. The effects of this herbicide are delayed and bud development in the spring, following a fall application, is prevented or severely limited. There is little or no leaching of fosamine through soil. Field tests have shown a half-life in soil of about one week.

GLYPHOSATE

TRADE NAME: ROUNDUP^{R}, RODEO^{R}, ACCORD^{R}, and others.

Glyphosate is commonly used in agriculture and as a home-use product. It controls a broad range of grasses, weeds, and woody brush species. Roundup is registered for uses on orchards, groves, vineyards, and in weed control prior to planting of grains, soybeans, corn, and other food crops. It is also registered for control of grass and weeds in recreational areas, schools, parking lots, and other public grounds. Rodeo is labeled primarily as an aquatic herbicide, but is also labeled for forestry. Accord is registered for forestry, but without the Roundup surfactant, it may be applied to water without Roundup's potential damage. Glyphosate is used in forestry for site preparation and release. Methods of application include cut-surface treatments and foliar spray. Glyphosate is readily absorbed by foliage and primarily affects plants by disrupting photosynthetic processes. Glyphosate has practically no leaching tendency because it binds tightly to soil. In soil, it is highly susceptible to degradation by micro-organisms, being converted to natural products such as carbon dioxide and water. Persistence in soils is about two months or less.

HEXAZINONE

TRADE NAME: VELPAR^{R} L, PRONONE^{R} 5G, PRONONE^{R} 10G, and others.

Hexazinone is used to control wide variety of grasses, weeds, and woody plants. Hexazinone has a number of food crop uses including weed control in blueberries, sugarcane, pineapple, and alfalfa. It is also used extensively in Christmas tree plantations. In forestry, it is commonly used for site preparation and release. Methods of application include foliar spray, basal soil applications, granular applications to soil, and cut surface treatment. Hexazinone is a "soil-active" herbicide, is readily moved into soil, and is absorbed by plant roots with some foliage

absorption. Herbicide activity and lateral and vertical movement is limited especially in soils high in organic matter or heavy clay. It may affect nearby desirable plants outside the treated area which have roots growing within (or into) the treated zone. Hexazinone primarily affects plants by inhibiting photosynthesis. The degree of effect on plants depends on susceptibility of the species, rate of application, and soil texture. In soil, hexazinone is subject to microbial degradation. Half-life in soil varies from 1-6 months depending on soil and weather.

IMAZAPYR

TRADE NAME: ARSENAL^R, ARSENAL^R Applicators Concentrate, CHOPPER^R, and others

Imazapyr is used for the control of weeds, grasses, and woody plants in forestry including site preparation and release. It is also labeled for weed control under pavement at industrial sites and rights-of-way. Methods of application include cut-surface treatments, foliar spray and basal bark spraying. Imazapyr is absorbed through foliage and roots and is rapidly moved throughout the plant. Imazapyr accumulates in growing tips of plants and affects susceptible species slowly, yellowing newest leaves first and then spreading throughout the plant. Imazapyr can enter the soil, but lateral and vertical movement is limited. It persists in soil 3-12 months depending on the amount used and the weather. It may affect nearby desirable plants outside the treated area which have roots growing into the treated zone. Imazapyr photodegrades and, to a lesser extent, biodegrades. Imazapyr has minimal effect on soil microflora.

PICLORAM

TRADE NAME: TORDON^R 101, TORDON^R 101R, TORDON^R K, and others.

Picloram's uses include noxious weed control, rights-of-way, facilities maintenance, and rangeland improvement. In forestry it is used to control woody plants and weeds. Methods of application include cut-surface treatments and foliar spray. Picloram is primarily a growth regulator. Herbicidal action is a result of absorption through leaves and some uptake through roots. It is easily translocated in plants and accumulates in new growth causing leaves to cup and curl. Picloram is water soluble and can move in sandy soils low in organic matter. It may affect nearby desirable plants outside the treated area which have roots growing into the treated zone. Degradation by soil micro-organisms is slow and primary breakdown is by ultra-violet light. Persistence in soils varies by type of soil and weather but may exceed 100 days.

SULFOMETURON METHYL

TRADE NAME: $OUST^R$.

Sulfometuron methyl is a broad spectrum, pre- and post-emergence herbicide. Its labeled uses include selective weed control in turf grass, roadsides, and other non-cropland applications. It is registered for control of undesirable herbaceous plants in pine reforestation sites. The method of application normally is foliar spray. Sulfometuron methyl is absorbed through the plant leaves, with some absorption by roots. In the plant, it suppresses and stops plant growth by arresting cell division in growing tips. Sulfometuron methyl is hydrolyzed in soil and persists approximately 4 weeks.

TEBUTHIURON

TRADE NAME: $SPIKE^R$ (several formulations), $GRASLAN^R$, and others.

Tebuthiuron is a broad-spectrum, soil-applied herbicide used for weed and brush control in range, pasture and non-cropland applications. Its labeled uses include control of woody plants and weeds for maintenance of utility rights-of-way. It is usually applied to the soil as a granule, pellet, or wettable powder. The mode of action of tebuthiuron in plants is to inhibit photosynthesis. It is slowly absorbed by plant roots and may take up to three years to kill some species. Tebuthiuron is moderately mobile in most soils and is persistent from 1-3 years. It may affect nearby plants outside the treated area that have roots growing into the treated zone. It is primarily broken down by soil micro-organisms.

TRICLOPYR

TRADE NAME: $GARLON^R$ 3A, $GARLON^R$ 4, and others.

Triclopyr is a broad-spectrum herbicide originally developed for control of vegetation along utility rights-of-way and on industrial sites. In forestry, it is labeled for site preparation and release. Methods of application include cut-surface treatments, foliar spray, and basal bark spray. Triclopyr is primarily absorbed by plant leaves and is readily moved throughout the plant. It affects plants by interfering with normal growth processes. In soil, triclopyr is not highly mobile. It is rapidly broken down by soil micro-organisms and ultra-violet light, persisting an average of 30-56 days depending on soils and weather. Its half life in water is about 10 hours at 72°F.

2,4-D AND 2,4-DP

TRADE NAME: WEED RHAP A-4D®, Weedone® 2,4-DP, Esteron® 99, and others, and as a major component of Tordon 101* and Tordon 101®.

2,4-D and 2,4-DP are used to control broadleaf plants in food crops, pastures, lawns, rights-of-way, and range lands. They are used for brush and kudzu control in forestry. Labeled uses include site preparation and release. In the South, 2,4-D is not widely used in forestry work. Methods of application include cut-surface treatments, foliar spray, and basal bark sprays. Amine formulations are generally used for cut-surface treatments and esters for foliar spray and basal bark applications. 2,4-D and 2,4-DP are hormone-type growth regulators. They are absorbed by plant leaves, stems, and roots and moved throughout the plant. Accumulation occurs in growing tips. Salts of 2,4-D can move in sandy soils. Soil micro-organisms break them down in 1-4 weeks.

b. Manual Ground

Tools used for manual ground application of herbicides deliver herbicide in a variety of ways. Application of liquids include basal, soil-spot, foliar, and cut-surface treatments. Granules can be applied directly by hand or a hand-held spreader.

Liquid Application

Basal applications are used for release, precommercial thinning, and right-of-way maintenance, though some site preparation work is also done this way. A spray gun or wand is used to direct the spray at a target stem. Two types of basal applications are used:

- Full basal treatments are applied to trees up to 5 inches in diameter. The lower 12 to 20 inches of the stem is wet with herbicide on all sides.

- Streamline treatments are applied to smaller juvenile stems. Herbicide is applied to one side of the stem in a 1.5- to 2-inch band.

Soil-spot applications are used for site-preparation and release (and some right-of-way) treatments. Soil-active herbicide is sprayed onto the soil in the treatment area. Three basic patterns of spray application are commonly used:

- Spot grid treatment is commonly used on sites with many stems per acre. Spots of herbicide are applied to the soil in a regular pattern.

- Individual stem treatment is applied by spraying the soil around unwanted plants.

- Spot-around treatments are made by spraying herbicide spots on the ground around the desired plant.

Foliar applications are used to release first or second year stands from competition. Liquids are sprayed onto leaves of target plants in full leaf and growing.

- Directed foliar spray application is used to release young stands from competition less than 6 feet tall. Herbicide is generally applied to hit target vegetation but miss desired plants.

- Herbaceous weed control is done by applying herbicide directly over the top of all plants including desired plants to control competing vegetation. Herbicide is sprayed in a 4-5 foot circle or in a continuous band.

Cut-surface treatments are used to eliminate competing trees or control resprouting of stumps during site preparation, precommercial thinning, and release operations. Three types of treatments are used:

- Tree injection is most efficient on sites with sparsely distributed stems greater than 2 inches in diameter.

- Frill or girdle treatments involve cutting through the bark with an axe or hatchet to expose the cambium. The cut surface is then completely wet with herbicide. Girdles are formed by a completely encircling ring of cuts. Frilling is a less complete ring of cuts.

- Cut-stump treatments are applied to stumps of any size to reduce sprouting. A sprayer is used to thoroughly wet the cambial area (about the outer 1 inch) of the stump.

Spray solutions are normally carried in backpack tanks which hold between 1 and 5 gallons. These tanks have a diaphragm pump with a lever which allows the worker to pressurize the tank. Herbicide is applied to the target via a hand-held gun or wand attached to the tank by a flexible hose. Within the gun or wand mechanism is a valve system controlled by a trigger, which allows the worker to start or stop application of the chemical. Application is made as a continuous flow or as a predetermined volume of liquid per pull of the triggering device. Depending on type of nozzle used in the gun or wand, a large droplet spray or a continuous stream of liquid is delivered.

Spray treatments are used for all vegetation management operations. The specific purpose of the project determines the type of tool used. To fully cover foliage (broadcast application), a gun or wand which dispenses a continuous

flow of chemical through a spray nozzle is commonly used. Should a directed spray be desired (selective treatment) a spotgun or wand and a stream nozzle are most commonly employed. When treating freshly cut stumps a continuous stream of herbicide from a spotgun or wand is used to soak the cambial area of the stump.

Sprays are subject to drift, while continuous streams can splash back off the target vegetation. Weight of the tank makes the worker more subject to tripping in uneven terrain. Improperly maintained equipment is likely to leak on the worker. The hose between the backpack and hand unit can snag on vegetation and break, causing a spill of chemical directly onto the worker.

Tree injectors are closed hollow tubes (liquid tanks) which can be refilled at the top and which deliver liquid through a valve at the bottom. The valve end of the injector has a 1-2 inch blade used to cut through tree bark to expose the cambium. The injector is jabbed into a tree, a lever or string (trigger) is pulled, and herbicide solution is delivered into the cut.

A second form of injector is a modified hatchet called a hypo-hatchet. The cutting edge is about 1-2 inches wide and a hose and valve system are added. The hose connects the hatchet with a container attached to the applicator's belt. Herbicide is discharged into the cut by gravity and a piston system each time the hatchet hits.

A combination of injection and spraying using an axe and hand-held sprayer is the method called hack-and-squirt. A narrow-bladed hatchet is used to cut the bark of the target tree and a squirt bottle (held in the other hand) is used to apply herbicide to the cut.

All injection methods are target specific and are useful where selectivity is desired. These tools are most efficient where target species are sparsely distributed and stems are larger than 2 inches in diameter.

Injecting trees is a labor-intensive activity, so worker fatigue and safety can become limiting factors to productivity. Injector nozzles clog with bark and wood chips and need to be cleaned frequently. Splash from injecting into cuts causes the tool to become coated with herbicide during the work day. The hypo-hatchet is a very sloppy tool if not carefully maintained. Moreover, workers can be exposed to spray during the cut stroke and when the tool is removed from the cut. Squirt bottles used in the hack-and-squirt method are difficult to maintain and leak after only limited use.

Granule Application

Granules are manually applied by hand or hand-held spreaders. Treatments can be either selective or broadcast.

- Broadcast treatments scatter herbicide granules in a relatively uniform pattern throughout the treated area.

- Selective treatments locate target and non-target vegetation and place the granules either near the unwanted plants (to reduce its growth), or away from a desirable plant (to release it as in spot-around).

To hand-spread granules, only a sack and personal protective equipment are needed. Wearing gloves, workers carry the herbicide in a sack and throw the granules onto the ground. Hand-held granule spreaders are generally fertilizer spreaders: hoppers with a crank-operated rotating disk attached below. Granules pass through a small opening in the hopper onto the disk and are thrown from it when the crank is turned.

Granules are most commonly applied for site preparation, release, or right-of-way maintenance. They pose less risk to workers than liquid herbicides since there is less exposure to the herbicide (appendix A).

Granules require rain to release them into the soil where they become active, but they are subject to surface runoff in heavy rainfall. Additionally, they can bounce on impact and often tend to roll to the bottom of a furrow. This localized accumulation of granules can result in uneven control of vegetation.

c. Mechanical Ground

Many mechanical systems are available to apply herbicides. Units are available to mount on crawler or rubber-tired tractors, skidders, tree shearers, or truck beds.

Mechanical ground equipment is normally designed to broadcast granules or sprays. Risk of exposing the applicator to herbicide is less than for manual ground methods. In addition, fewer workers are required.

All mechanical ground tools are subject to site-related restrictions; slope, soil, and proximity to streams must be evaluated to determine tool suitability. These methods allow for large area coverage in relatively short periods of time, but they are not target selective; selectivity results from choice of, rather than placement of, herbicide.

Liquid Application

Mechanical tools for dispensing liquid herbicides have some common features. All have a tank (generally 25-300 gallons), a pump, a delivery system which controls the flow of herbicide, and nozzles which produce large spray

Injector

Granular spreader

Hypo-hatchet

Backpack sprayer with spotgun attachment

Axe and sprayer

Helicopter spraying

droplets. The shape of many of parts and overall configuration of the tool vary greatly, based on economics and proposed use. Most sprayers are controlled by the driver of the machine, though some require an operator in addition to the driver. Sprayers are commonly mounted on crawler tractors for use in forestry settings, though some rubber-wheeled tractor or skidder use is seen. For maintenance of roadside rights-of-way truck mounted units are most common.

Fixed-position booms similar to those used for agriculture (20-foot-wide boom with as many as 21 nozzles mounted at uniform intervals along the boom) are sometimes used in forestry or rights-of way maintenance. It is, however, more common to see one or two clusters of "raindrop"-producing nozzles mounted on a short movable boom. A long boom (15 feet) has been developed for doing release work in heavily wooded areas. The boom is mounted vertically at the back of a crawler tractor with the nozzles broadcasting herbicide which rains down onto fairly tall vegetation.

The most common application pattern for mechanical sprayers is broadcast spray in narrow or wide bands. Electric systems, however, allow operators to vary position of boom and placement of spray with a fair degree of accuracy. Electric boom-positioning controls are more common on units designed for roadside maintenance.

Granule Application

Granule spreaders are large, rugged units which can be powered by the machine on which they are mounted or by an independent power source. The spreaders either throw or blow the pellets away from a dispensing tube.

They are used primarily for site-preparation or release work where broadcast herbicide application is appropriate. Granules tend to bounce and roll on impact, often rolling together in small depressions. This can cause spotty results or too much herbicide in one area.

d. Aerial

In the Southern Region application by helicopter is the only aerial method evaluated. Granules and liquids can be applied aerially. The herbicide tank or hopper is mounted outside the cabin, reducing pilot exposure to the chemical. Due to the large amount of herbicide which can be applied daily, the mixer/loader is exposed to greater risk of exposure than in a ground-mechanical project. Aerial application requires very few workers.

Aerial methods are useful for site preparation, release operations and right-of-way maintenance. Aerial delivery systems are most effective on larger areas. Due to environmental and economic considerations aerial, treatment is rarely practical for less than 20-25 acre blocks.

Drift is a primary concern during aerial operations. Uniformly large droplets and relatively heavy pellet weight prevent significant drift from occurring. However, more care must be taken to ensure proper safety standards.

Aerial operations are broadcast applications, and the pilot has limited ability to treat specific target plants. He can manipulate position and speed of his aircraft, can start or stop herbicide flow, and often has control of the flow rate of the herbicide. But these controls are rather inexact when compared with manual ground applications. Selection of the proper herbicide is critical to the success of an aerial application project.

Liquid Application

Aerial systems for applying liquids are boom/nozzle systems such as the microfoil boom. The system generates streams of liquid which, in the wake of the boom, break into droplets as a result of air turbulence. Droplets formed in this manner are relatively large and uniform. Another system being tested (through-the-valve boom or TVB system) is also designed to generate large droplets. Booms are mounted under the body of the helicopter; but flow is controlled by the pilot or a passenger.

Granule Application

A specially designed spreader is suspended below the helicopter. Air flow through the mechanism distributes the granules in the helicopter's wake. The hopper and feed mechanism is outside the cabin but is controlled by the pilot or applicator.

e. Herbicide Use Classification

Table II-1 lists herbicides based on results of the risk assessment (appendix A). It assumes typical application rates and typical exposures (tables 4-4 through 4-6, appendix A). It also assumes that all protective measures described in this chapter are in place. Combinations of chemicals and application methods are classified as follows:

- Class A - Do not pose risk which would require mitigation in addition to those stated in chapter II (section E.2.c.).

- Class B - Pose human or wildlife health risk which requires additional mitigation, **OR** have soil-active half-lives (appendix A, table 4-9) exceeding 9 months.

- Class C - Pose human or wildlife health risk which requires additional mitigation, **AND** have soil-active half-lives (appendix A, table 4-9) exceeding 9 months.

- Class D - Pose a risk to human or wildlife health or to the environment which cannot be mitigated to an acceptable level of risk.

Table II-1.--Classification of chemical/method combinations when used at typical rates and exposures (tables 4-4 through 4-6, appendix A)

Class[1]	A	B	C	D
Manual ground:				
Cut surface	DIC; GLY; IMZ; PIC; TRA	2,4-DA		
Basal stem	2,4-DP; DES; KER; LIM; TRE	2,4-DE		
Soil spot	HEX	TEB		
Foliar spray	FOS; GLY; HEX; IMZ; KER; LIM; PIC; SMM; TRA; TRE	2,4-DA; 2,4-DE; 2,4-DP	TEB	
Mechanical ground	2,4-DP; DES; DIC; FOS; GLY; HEX; IMZ; KER; LIM; PIC; SMM; TRA; TRE	2,4-DA; 2,4-DE; TEB		
Aerial	2,4-DP; DES; FOS; GLY; HEX; IMZ; KER; LIM; PIC; SMM; TRA; TRE	2,4-DA; 2,4-DE; TEB		

KEY:
2,4-DA = 2,4-D Amine
2,4-DE = 2,4-D Ester
DIC = Dicamba
DES = Diesel
FOS = Fosamine
GLY= Glyphosate
HEX = Hexazinone
IMZ = Imazapyr
KER = Kerosene
LIM = Limonene
PIC = Picloram
SMM = Sulfometuron Methyl
TEB = Tebuthiuron
TRA = Triclopyr Amine
TRE = Triclopyr Ester

1 Class is based on the analysis in the risk assessment (appendix A), ANY change from conditions evaluated in the risk assessment will affect proper placement of the chemical/method combination within the table. Note also that this table is intended for use in general forest or right-of-way conditiions. Where threatened, endangered or sensitive species are present appropriateness of the chemical/method combination will be determined during the preparation of the project environmental analysis.

When additional mitigation is required, several options are available: select a different herbicide; reduce amount of herbicide applied per acre; shorten the workers' work day; change method of application; etc. Selection of additional protective measures is done during site-specific project analysis.

5. Biological Methods

Biological methods intentionally use living organisms to suppress, inhibit, control, or eliminate growth of herbaceous and woody vegetation. For the purpose of this EIS, grazing by domestic livestock will be evaluated as a viable biological control method only within current grazing allotments that can effectively contain the animals.

Researchers are currently evaluating other potential methods of biological control. Some experimental methods show promise but are not currently operational for forestry. These methods include microbial and viral agents (biological herbicides); plant pathogens, insects, nematodes, genetics (natural adaptability and plant breeding); competition (interspecific); allelopathy (plants affecting other plants through chemical inhibitors); and biodegradable mulches. When any of these methods are determined to be successful at operational levels, they will be evaluated for use in the region's vegetation management program. Their use will then be coordinated through all applicable state and federal programs and regulations.

On national forests, grazing animals (domestic livestock) such as cattle, horses, sheep, and goats are in limited use as biological control methods primarily in the western United States. Little use has occurred in the eastern United States. When domestic livestock are used, the objective is vegetation control through prolonged grazing, not animal weight-gain. Numbers of livestock used in an area are increased to a point where target vegetation is effectively removed. Once the project objective is achieved, stocking levels are returned to normal allotment guides.

Effectiveness of grazing for vegetation control depends on size of area, amount of control needed, types and amounts of herbaceous and woody species present, and feeding selectivity of animals used. For example, on an area where herbaceous species are to be controlled, cattle may be appropriate because they are more likely to graze grasses, grass-like plants, and forbs. Where woody species are to be controlled, goats may be more appropriate because a higher component of their diet consists of woody browse species.

Desirable herbaceous and woody species are susceptible to overbrowsing and trampling. Moreover, risks of soil erosion and compaction are high from overgrazing. Conflicts with wildlife can also occur in areas with habitat limitations or restrictions (such as seasonal food shortages). Location of water sources, proper fencing or herding requirements, availability of livestock, and economics can also be limiting factors.

E. MANAGEMENT REQUIREMENTS AND MITIGATION MEASURES

This section describes management requirements and mitigation measures. Management requirements set direction on how resources are managed (such as timber stocking standards). Mitigation measures are actions necessary to lessen adverse impacts or to enhance beneficial effects (such as streamside protection) . These requirements and measures do not apply to alternative A, in which treatment-related impacts do not occur. There are two groups:

General management requirements and mitigation measures. These apply to all methods.

Method-specific management requirements and mitigation measures. These measures pertain only to prescribed fire, or only to mechanical methods, and are in addition to the general requirements and measures. Combinations of methods vary by alternative so the applicability of individual management requirements or mitigating measures varies. For example, alternative D excludes the use of herbicides. Any measure or requirement about herbicides does not apply to alternative D.

1. General Management Requirements and Mitigation Measures

The following general requirements and measures apply to all vegetation management methods. Each forest may be more restrictive, but not less.

a. Site-Specific Analysis

(1) Projects will have site-specific analysis, in accordance with the National Environmental Policy Act (NEPA). This environmental analysis will consider site-specific techniques, intensity of application methods, and potential environmental effects of any method considered. A reasonable range of alternative methods, including the use of methods which do not involve herbicides, will be examined and evaluated.

Potential adverse (including cumulative) effects will be evaluated. Where appropriate, some effects considered are long-term soil productivity, water quality, air quality, vegetation diversity, wildlife, fish, cultural resources, and threatened, endangered, and sensitive species.

An additional mitigation measure determined by the socioeconomic analysis in chapter IV is that effects on civil rights, including those of minorities and women, will be evaluated during site-specific analyses.

The intent of this requirement is to ensure adequate environmental analysis. Monitoring is provided by public disclosure under NEPA and through internal reviews. Congress and the Council on Environmental Quality have recognized the effectiveness of NEPA in developing environmental awareness and protecting the human environment.

(2) A biological evaluation of how a project may affect any species Federally listed as threatened, endangered, or proposed for listing, or identified by the Forest Service as sensitive, will be conducted as part of the site-specific environmental analysis process.

The site-specific biological evaluation considers all available inventories of threatened, endangered, proposed, and sensitive species populations for the proposed treatment area. When adequate population inventory information is unavailable, it will be collected when the affected site has high potential for occupancy by a threatened, endangered, proposed, or sensitive species. Appendix D (biological evaluation) identifies any potential adverse effects from vegetation management by species. When potential adverse effects are indicated, mitigation measures specified in appendix D and in this chapter will be used to prevent adverse effects.

Requirements and measures for activities affecting threatened, endangered, or proposed species are detailed in species recovery plans and in FSH 2609.23R. Recovery plans have been prepared for the southern bald eagle, red-cockaded woodpecker, wood stork, Mississippi sandhill crane, eastern indigo snake, and Harpers beauty. Chapters in FSH 2609.23R have been prepared for red-cockaded woodpecker, southern bald eagle, Mississippi sandhill crane, and American alligator. Requirements and measures for activities affecting sensitive species are detailed in Forest Land and Resource Management Plans.

When, despite mitigation measures, the evaluation indicates that a project may have any adverse effect on a species or the habitat of a species listed as threatened, endangered or proposed, formal consultation or conference with the U.S. Fish and Wildlife Service will be initiated to assure that project activities are not likely to jeopardize the continued existence of a species.

When the evaluation indicates that a project may have any adverse effect on a species or the habitat of a species listed as sensitive, appropriate State wildlife agencies, natural heritage commissions, and other cooperators or species authorities will be contacted to identify coordination measures. These measures will be directed towards ensuring species viability and preventing negative population trends that would result in Federal listing.

The intent of this requirement is to afford protection to threatened, endangered, proposed, and sensitive species. Monitoring is provided through public disclosure under NEPA and through U.S.D.I. Fish and Wildlife Service consultation procedures.

(3) In each project, water quality will be protected from nonpoint-source pollution through use of preventive "best management practices" (BMP's). A process will be followed that includes implementation of BMP's, monitoring and evaluation of their application and effectiveness, and adjustment of practices as needed to protect beneficial water uses and comply with State water quality laws.

BMP's are applied to all activities in all alternatives. Some BMP's required to protect water quality appear in this section as mitigation measures for soil and water. BMP's applied in projects may be more stringent and more effective in protecting water quality, but not less. In each project, site-specific conditions will be assessed, and the BMP's specified here, plus any others needed to meet State water quality standards, will be employed.

The intent of this requirement is to protect water quality and assure compliance with State water quality laws. Monitoring is provided through evaluation of BMP application and analysis of water quality on key projects.

b. Timber Stand Improvement (TSI)

(4) Methods that maintain stocking levels (stems per acre) and improve growth rates are used (table II-2).

Table II-2.--*Southern Region restocking standards: number of desirable stems per acre.

Forest Type	Lower Level	Target Level	Upper Level
Loblolly pine	300	500-700	900
Shortleaf pine	300	500-700	900
Slash pine	300	500-700	900
Longleaf pine	400	600-900	1,200
White pine	150	250-350	500
Virginia pine	300	500-700	900
Sand pine	300	500-700	900
Mixed pine-hardwood	300	400-600	900
Hardwoods (all species)	150	250-350	500

* Stocking levels shown are guides, and must be used in conjunction with professional judgment to determine restocking levels for a specific site. Levels prescribed by Forest Land and Resource Management Plans may be more specific.

(5) Pine stands receive release and weeding necessary to meet growth rates and stocking levels established in Forest Land and Resource Management Plans. Stands are considered for release when the desired seedlings are not free to grow, when competing growth threatens to overtop and compete directly for moisture and nutrients, or when competition results in less-than-average growth for comparable sites.

(6) Precommercial thinning of pine (usually done before age 10 to 15 years) is considered when stem density exceeds the upper level of restocking standards.

(7) Hardwood stands are generally not released. Clumps of competing stems are removed, however, where they may significantly interfere with desired trees.

(8) Hardwood stands, where codominant trees of seedling (not sprout) origin are 25 feet or taller, are considered for precommercial thinning.

The purpose of requirements (4), (5), (6), (7), and (8) is to promote stand structures, compositions, and conditions

that fully utilize the productive potentials of sites. Monitoring is accomplished through periodic inventories. Knowledge gained through research and many years of management experience and contained in silvicultural guides have shown these measures to be effective.

c. Soil and Water

(9) Channel stability of perennial and intermittent streams is protected by retaining all woody understory vegetation within five feet of the bank and by keeping slash out of the stream.

This requirement protects integrity of streams from excess channel erosion by minimizing channel obstructions and retaining living root systems on banks. Monitoring is accomplished through review of written activity plans and work site inspections. Beasley (1979), Patric (1976), and Ursic (1975) show that retention of bank vegetation is effective in controlling channel erosion.

d. Cultural Resources

(10) A cultural resource inventory is conducted when soil disturbing activities are anticipated. If archaeological or historical resources are encountered during project implementation, project work stops until an archaeologist evaluates the significance of the site's resource.

(11) Significant cultural resources are identified, evaluated, nominated, and protected. Determinations of eligibility for inclusion in the National Register of Historic Places are made.

The intent of requirements (10) and (11) is to protect, evaluate, or preserve significant cultural resources. Monitoring is done through inventories, evaluations, and periodic work site inspections. Experience shows that these measures are effective in ensuring compliance with Federal and State laws protecting cultural and historic resources.

e. Safety

(12) Safety equipment for Forest Service workers (such as hard hats, eye and ear protection, chaps, and fire retardant clothes) is worn as determined by a Job Hazard Analysis specified in the Health and Safety Code Handbook (FSH 6709.11). This analysis estimates risks to specific body parts and prescribes needed protection.

The purpose of this requirement is to provide personal protection and reduce the number and severity of accidents. Monitoring is done through supervisory controls and reviews of accident reports. Experience and analysis of past accidents allow for effective measures to prevent future occurrences.

f. Visual Quality

(13) Visual Quality Objectives (VQO) by method for corridor maintenance, site preparation, timber stand improvement, wildlife habitat improvement, range forage, and fuels treatment are:

<u>Preservation</u> allows for ecological change only. Generally, no treatments are permitted.

<u>Retention</u> ensures that human activities are not evident to the casual forest visitor. Some treatments are allowed, but shearing, raking, piling, disking, bedding, and broadcast herbicide methods are usually not appropriate.

<u>Partial Retention</u> means that human activities may be evident but remain subordinate to the characteristic landscape. Most treatments are allowed, but disking, bedding, and broadcast herbicides are limited. On corridors, all methods and tools are available.

<u>Modification</u> indicates that human activity may dominate the landscape, but utilizes line, form, color, and texture to give a natural appearance. All methods and tools are available for use.

<u>Maximum Modification</u> means that human activity may dominate the landscape, but should appear as a natural occurrence when viewed as background. All methods and tools are used, and at a greater intensity than in modification VQO.

(14) When compatible with project objectives, forest managers schedule treatments for the season that best meets visual quality contrast requirements. Visual diversity along travelways (such as canopy layering, flowering trees) is considered and protected from treatments where feasible. When using fire, char height and crown scorch limits are considered in foreground areas. Tool selection and coordination requirements are determined by a site-specific analysis at the project level.

Requirements (13) and (14) ensure consideration of established visual quality objectives. Monitoring is done through review of project proposals and on-site inspections. Experience shows that visual inventories and established visual quality objectives are effective in protecting the visual resource.

g. Wildlife and Aquatic Animals

(15) Wildlife stand improvement (WSI) seeks to improve species composition in hardwood stands and to develop wildlife habitat areas for game and nongame species. A variety of woody and herbaceous species suited to site, aspect, and burning regime are maintained to assure a year-round food supply. Treatments to improve habitat for species such as red-cockaded woodpeckers may reduce variety.

(16) For understory species WSI, proper management allows full sunlight on 30 percent of the forest floor. For hardwood overstory WSI, thinning encourages full crown development, vigorous growth, and fruit or mast production. When thinning stands older than 30 years, stems are favored which show positive indication of bearing fruit or mast.

(17) When conducting TSI, WSI, and site preparation, the Forest Service protects and manages selected groups of overstory and understory vegetation to assure a variety of fruit, hardmast, and cover species. Active and potential den trees are retained in clumps (at least 1/2 acre per 20 acres) if they are not provided in adjacent stands not suitable for timber production, inclusions, or streamside management zones. When conducting TSI and WSI, all recognized cavity trees are protected. At least two standing dead snags are retained per acre, in the form of large hardwood trees (greater than 12 inches) when possible. Appropriate treatments are used to create snags where natural snags are lacking.

The intent of requirements (15), (16), and (17) is to promote a variety of wildlife and to provide suitable habitat. Monitoring is accomplished through review of project proposals, on-site inspections, and periodic inventories. Effectiveness of these requirements is based

on principles of wildlife management and habitat requirements as described in USDA Forest Service Southern Region Wildlife Habitat Management Handbook (FSH 2609.23R 1980, USDA Forest Service Wildlife and Fisheries Habitat Improvement Handbook (1986), and general wildlife management texts such as Peek (1986).

h. Corridors

(18) Each forest works with utility special-use permittees to establish vegetation management objectives (such as wildlife, watershed, recreation, visual quality) for location of new transmission and pipeline corridors and maintenance of existing ones. These objectives determine maintenance techniques and strategies. When feasible, establishment and maintenance of low-growing shrubs and grasses are favored along transmission corridors where wildlife and aesthetic objectives are dominant in alternatives B, C, D, E, and G.

(19) To control erosion, establish and maintain permanent vegetation on the travelway of intermittent service roads when they are closed and on cut-and-fill slopes of all roads. Where practical, native flowering species are established, maintained, and enhanced in alternatives B, C, D, E, and G.

(20) Treat vegetation along trails according to maintenance levels identified in the publication "Trails South." Priority is given to correcting unsafe conditions, preventing resource damage, and providing for intended recreation experience level.

(21) Public safety and protection of capital investment are also considerations when prescribing vegetation management treatments along system roads and on utility rights-of-way.

Requirements (18), (19), (20), and (21) balance special use considerations with considerations for other forest values, allow for safe efficient use of facilities and limit adverse visual and erosion effects. Monitoring is done through project proposal reviews, periodic inspections, and maintenance plan reviews. Experience shows that careful coordination between resources and special uses effectively allows compatible, concurrent use.

i. Range Forage

(22) When managing for range forage species, wildlife and livestock use should not exceed 50 percent of current annual growth for key grass species, 20 percent of total annual production of key forb species, and 20 percent of current annual growth of key shrub species.

This requirement protects range forage from overuse and decline. Monitoring is done through allotment management reviews and periodic inventories. Years of management experience and field inventories or range species have determined optimum use levels.

2. Method-Specific Management Requirements and Mitigation Measures

These requirements and measures are in addition to general requirements and measures in the preceding section.

a. Prescribed Fire

The following apply to alternatives that use prescribed fire. Each forest may be more restrictive but not less.

(1) Site-specific planning for all prescribed burns is done by trained resource specialists and approved by the appropriate Forest Service line officer prior to project implementation. This planning includes such items as description of treatment area, burn objectives, weather factors and fuel moisture conditions, and resource coordination requirements. Coordination requirements include provisions for public safety, burn day notification of appropriate agencies and individuals, smoke management requirements, protection of sensitive features, as well as specific firing patterns, ignition methods, mop-up and patrol procedures. A post-burn evaluation will compare treatment results with plan objectives.

This requirement ensures thorough planning, well defined objectives, and selection of appropriate mitigating measures. Monitoring is accomplished through project proposal reviews, evaluations during the burn, and post-burn evaluations. Experience shows that planning and evaluation effectively eliminate avoidable adverse effects.

Timber Stand Improvement

(2) Initial prescribed burns in pine stands (except longleaf) to maintain or improve growth through reduction, control, or removal of competing species are not done until pines are 10 to 15 feet tall or 3 to 4 inches in diameter at ground level. For longleaf pine stands, burns can be used prior to height growth for brownspot disease control when root collars of grass stage seedlings are at least 0.3 to 0.5 inch in diameter. After initiation of height growth, burns can be used once seedlings are 3-5 feet tall.

This requirement ensures survival and vitality of crop trees. Monitoring is done in project proposal reviews and in post-burn evaluations. Research by Goebel, Brender, and Cooper (1967), Chen, Hodgkins, and Watson (1975), Johnson (1982), Mann and Whitaker (1955), Komarek (1974), and Wade (1986) has shown these measures to be effective in limiting damage and mortality.

Soil and Water Protection	(3) Slash burns are conducted so they generally do not consume all litter and duff and alter structure and color of mineral soil on more than 20 percent of the area in alternatives B, C, D, E, and G.
	(4) On severely eroded forest soils, any area with an average litter-duff depth of less than 1/2 inch is not burned in alternatives B, C, D, E, and G.
	The purpose of requirements (3) and (4) is to protect soil productivity. Monitoring includes project proposal reviews and post-burn evaluations. Maxwell (appendix B) and the analysis in chapter IV found these measures effective in preventing excessive losses of organic matter and nutrients.
	(5) Where needed to prevent erosion, water diversions are installed on firelines during their construction, and the firelines are revegetated promptly after the burn.
	(6) Firelines are not located within 30 feet of lakes or perennial or intermittent streams, unless tying into them as firebreaks at designated points. Low-intensity fires with one to two-foot flame lengths may be allowed to back into the 30-foot strip.
	Requirements (5) and (6) limit stream and lake siltation. Monitoring is done in project proposal reviews, during burns, and in post-burn evaluations. Cushwa (1970) found that prevention of fireline erosion effectively eliminates sedimentation from many burns.
Wetlands	(7) Firelines are plowed around wetlands only when the water table is so low that wildfire might otherwise burn wetland vegetation and organic matter.
	(8) If a fireline is required adjacent to a wetland, it is not plowed within the transition zone between the upland and wetland vegetation except to tie the fireline into a natural firebreak.
	(9) Plowed firelines are not located within savannahs except when needed for resource protection.
	The purpose of requirements (7), (8), and (9) is to prevent fireline scars which are very slow to heal in wetlands and savannahs. Additionally, hydraulic integrity of wetlands is protected. Monitoring is accomplished through project proposal reviews and post-burn evaluations.
Air Quality Protection	(10) Any management activities must comply with applicable air-quality laws and regulations and coordinate with appropriate air-quality regulatory agencies.

(11) The best available technology to control smoke emissions is used, including accelerated mop-up, rapid ignition techniques, and burning when moisture conditions limit total smoke production. Burning is not done during stagnant weather nor when weather forecasts indicate that smoke drift into highways, airports, heavily populated areas, or other sensitive areas may be hazardous.

The intent of requirements (10) and (11) is to comply with air quality regulations and protect health and safety. Monitoring includes review of project plans, pre-burn weather evaluations, and during-burn evaluations. USDA Forest Service (1976) and Sandburg and Ward (1983) demonstrated that these measures are effective in limiting smoke emissions.

Wildlife Stand Improvement

(12) Oak, oak-gum-cypress, and oak-pine stands and inclusions are protected when prescribed fire is applied, either through exclusion of fire or use of low-intensity fires.

This requirement protects tree species which are susceptible to damage from more intense fires. Monitoring is done through review of project plans and through post-burn evaluations.

Timing of Burns

(13) Generally, understory burns are not scheduled during nesting season to avoid disrupting reproductive activities. Forest managers may, however, use burns to meet specific objectives, such as protecting threatened and endangered species (particularly the red-cockaded woodpecker), reestablishing natural ecosystems, controlling brownspot disease and promoting longleaf height growth, and site preparation.

An additional mitigation measure identified by the analysis in chapter IV is that periodic growing season underburns are not allowed on the same site more than twice in succession without an intervening dormant season burn.

The purpose of these requirements is to minimize wildlife reproduction disruptions and to prevent soil damage due to excessive nitrogen loss. Monitoring occurs in project plan reviews.

Preplanning and Execution of Burns

(14) Burns are planned to maximize opportunities for breaking up large continuous fuel types and providing the most desirable distribution of burns for wildlife habitat. When consistent with specific burning objectives, execution of the actual burn is carried out to create a mosaic pattern in fuel types to further complement fuel treatment and wildlife objectives in alternatives B, C, D, E, and G.

This requirement ensures vegetation variety. Monitoring is done in project plan reviews and in post-burn evaluations.

Effectiveness of measures (12), (13), and (14) is based on principles of wildlife management and habitat requirements as described in the USDA Forest Service Southern Region Wildlife Habitat Management Handbook (FSH 2609.23R 1980, USDA Forest Service Wildlife and Fisheries Habitat Improvement Handbook(1986), and general wildlife management texts such as Peek (1986).

b. Mechanical Method

The following requirements apply to alternatives that use mechanical methods of vegetation management. Each forest may be more restrictive but not less.

Soil and Water Protection

(1) Prompt revegetation is done if treatment activities leave insufficient ground cover to control erosion by the end of the first growing season.

(2) Mechanical equipment is restricted to sustained slopes of less than 35 percent on stable soils, and 20 percent on unstable soils.

(3) On sustained slopes steeper than 15 percent or on severely eroded soils, only chopping, mowing, shearing, ripping and scarifying are used.

(4) To limit soil compaction, no mechanical equipment except mowers is used on plastic soils when the water table is within 12 inches of the surface, or when soil moisture exceeds the plastic limit. Soil moisture exceeds the plastic limit if the soil can be rolled to pencil size without breaking or crumbling. Compaction can be corrected by careful ripping, bedding, or disking in alternatives B, C, D, E, and G.

(5) Disk and rip on the contour so that grade of furrows does not exceed 5 percent. Chop so that final blade depressions parallel the contour.

(6) Bedding is done on level, wet sites only when needed to ensure survival and growth of managed trees. Beds should have an initial height no greater than 15 inches from ground level and should blend with the natural landform as closely as possible.

(7) Windrows and piles are spaced no more than 200 feet apart to limit soil exposure, soil compaction, and nutrient loss from piling and raking.

(8) Mechanical equipment is not operated within 30 feet of lakes, or perennial or intermittent streams, or within any defined stream channel except to cross at designated points.

The intent of requirements (1), (2), (3), (4), (5), (6), (7), and (8) is to minimize soil damage or loss and subsequent sedimentation. Monitoring is done in project plan reviews and post-project evaluations. Beasley and others (1986), Blackburn and others (1986), and Gent and others (1983, 1984) found these measures to be effective and necessary to control soil damage and loss.

Corridors

(9) All trails, roads, ditches, and other improvements in the project area are kept free of logs, slash, and debris. Any road, trail, ditch, or other improvement damaged by operations is promptly repaired.

This requirement protects improvements. Monitoring is done in project plan reviews and post-project evaluations. Experience shows that improvements are impacted by other activities. Preventive measures or prompt repair effectively minimizes damages.

c. Herbicide Method

The following requirements apply to alternatives which use herbicides. Each forest may be more restrictive but not less.

Requirements

(1) Only herbicides registered by EPA and approved by the Forest Service are applied. In addition to this environmental impact statement, policy established by the Chief and the Regional Forester plus direction established by Forest Supervisors are considered when evaluating herbicide selection for a project.

(2) A site-specific environmental analysis is prepared for the area to be treated. It identifies measures required to reduce offsite movement, drift potential, and adverse effects on threatened, endangered and sensitive species, non-target vegetation, species diversity and richness, human health and wildlife safety, and any other relevant environmental elements. This analysis plus known effectiveness of possible treatments will be used to determine the appropriate herbicide, application method and rate.

(3) Herbicides are applied in accordance with labeling information. Review the labeling at the time of application to ensure proper use to protect threatened, endangered or sensitive species, wildlife, or human health, or other environmental elements such as water or soil. Site specific conditions may require further limitations beyond those specified on the labeling, but relaxing labeling standards is not permitted.

(4) Herbicides are applied (alternatives B, C, E, and G) in accordance with recommended guidelines established for human health (NRC 1983) and wildlife safety (EPA 1986). Application is at the <u>lowest</u> effective rate necessary to accomplish project objectives. Application rate and work time will not exceed the those shown as <u>typical</u> (tables 4-4 through 4-6, appendix A) unless a supplementary assessment of risk establishes that proposed rates will not cause unacceptable risk to human health, wildlife or other environmental elements.

(5) When selecting an application method (alternatives B, C, E, and G) preference is given to those which affect the minimum amount of vegetation (target selective) and cause the minimum site disturbance while still meeting project objectives and posing least risk to people, wildlife and other environmental elements.

Application methods which are available for use are listed below from most to least target specific:

1) Cut surface treatments
2) Basal stem applications
3) Directed foliar treatments
4) Soil spot (spot around) treatments
5) Soil spot (spot grid) treatments
6) Manual granular treatments
7) Manual or mechanical broadcast treatments
8) Helicopter broadcast treatments

(6) Choice of herbicide/method of application will be made to minimize adverse effects on human health, wildlife, and the environment (alternatives B, C, E, and G). The following criteria apply to information in table II-1:

- Class A herbicide/method combinations are first choice for the manager.

- Class B combinations are used only when project objectives cannot be met with a Class A herbicide, and then only when adverse effects are mitigated to an acceptable level.

- Class C combinations are available when no herbicide in Class A or B would achieve the project objective (eg. poisonous plant or noxious weed control), and then only when adverse effects can be mitigated.

- Class D herbicides/method combinations are not used.

(7) Within labeling constraints, timing of herbicide application (alternatives B, C, E, and G) is planned to maximize desired effect on target vegetation while minimizing effects on non-target vegetation and other environmental elements. Safety concerns include anticipated public use such as viewing, hiking, berry picking, or fuelwood gathering.

Requirements (1) through (7) ensure legal compliance but also mandate that alternative aproaches be thoroughly evaluated where unacceptable levels of risk of adverse effects have been identified in order to minimize these risks and effects. Monitoring of project documentation and reviews of purchase orders and annual herbicide use reports are done to ensure compliance.

Threatened, Endangered, Proposed and Sensitive Plants and Animals

(8) To protect the endangered gray bat and Indiana bat, 2,4-D, 2-4DP, or triclopyr is not applied aerially within 300 feet or by any ground application method within 60 feet of known occupied gray or Indiana bat habitat. To protect the endangered Florida scrub jay, the same

restrictions apply to 2,4-D and 2,4-DP. All plants listed as threatened, endangered, or proposed are protected by the same distance restrictions when applying any herbicide.

To protect the following sensitive animal species, the same restrictions apply for 2,4-D: star-nosed mole, Florida mouse, old-field mouse, masked shrew, southern shrew, southern pygmy shrew, and red-backed vole. All plants listed as sensitive are protected by the same restrictions shown for threatened, endangered, and proposed species.

The purpose of this measure is to protect these species from risk of toxicity from the specified chemicals as predicted by the risk assessment (appendix A).

Public Notification

(9) Notice signs as shown in FSH 7109.11 are posted. Special care is taken to clearly post areas with anticipated visitor use. Individuals living within one-fourth mile of an area are notified of proposed aerial treatments during project planning.

The purpose of this requirement is public notification to prevent accidental exposure. Monitoring occurs during project plan reviews and in post-project evaluations. Effectiveness varies with different segments of the public, but experience has shown that people generally avoid risk if they are informed that risk exists.

Supervision and Training

(10) All Forest Service application crews are supervised by a certified pesticide applicator. Crew members are trained in safe application procedures, personal safety, proper handling of herbicides, and proper disposal of empty containers.

(11) The Contracting Officer's Representative (COR) for each contract application project is a certified pesticide applicator. The COR is responsible for certifying compliance. Contract inspectors are trained in herbicide use, application, and handling.

Requirements (10) and (11) ensure compliance with labeling instructions and minimize risks of accidents. Monitoring is accomplished through the Pesticide Applicators Training and Certification program. Effectiveness is ensured through the certification program where testing is required, with a minimum score of 70 percent necessary for certification.

Protective Clothing

(12) Forest Service applicators must wear a long-sleeved shirt and long pants made of tightly woven cloth. These clothes must be cleaned daily. Also, workers must wear a hard hat with plastic liner, waterproofed boots, gloves, and other safety clothing and equipment required by labeling.

(13) Additional safety items are taken to the application site by all Forest Service crews (includes soap, wash water that is separate from drinking water, eyewash bottles, first aid equipment, and extra clothing in case of accidental contamination of worker's clothing).

(14) Contractors ensure use of proper protective clothing and safety equipment required by labeling for the herbicide and application method in alternatives B, C, E, and G.

Requirements (12), (13), and (14) protect the health and safety of handlers, applicators, and mixers. Monitoring is done through supervisory controls and reviews of accident reports. Research by Lavy, Mattice, and Norris (1984), Webster and Marbach (1985), and Yi-Lan and others (1984) concludes that protective clothing effectively reduces exposure.

Weather Conditions

(15) Weather conditions are monitored and the project is suspended if temperature, humidity, or wind become unfavorable as indicated below:

	Temperatures Higher Than	Humidity Less Than	Wind (at target) Greater Than
Ground:			
Hand (Cut Surface)	N.A.	N.A.	N.A.
Hand (Other)	98°F	20%	15 mph
Mechanical (liquid)	95°F	30%	10 mph
Mechanical (granular)	N.A.	N.A.	10 mph
Aerial:			
Liquid	90°F	50%	6 mph
Granular	N.A.	N.A.	10 mph

This requirement minimizes risk of off-site contamination from drift of droplets or volatilized material. Monitoring includes weather monitoring before, during, and after operations. Research by Yates and others (1978) showed these requirements to be effective in reducing drift.

Transportation and Storage

(16) During transport of herbicides, containers are secured to prevent tipping or excess jarring.

(17) Herbicides, additives, and equipment required for an application are carried in a part of the vehicle isolated from the driver and passengers. Food items, livestock feed, and clothing are also isolated from herbicides.

(18) Only the quantity of herbicide needed for the day's application is brought to the site. At the end of the day, any left-over herbicide is returned to storage.

Requirements (16), (17), and (18) minimize or eliminate potential risks from accidental spillage during transport. Monitoring is done through supervisory controls. Experience has shown these measures to be very effective in preventing spillage and contamination.

Mixing and Application

(19) Herbicide mixing, loading, or cleaning areas are not located within 200 feet of private lands, open water (such as streams, ponds, wells), or other recognized sensitive areas.

(20) During use, equipment for storage, transport, mixing, or application of herbicides is inspected daily for leaks.

(21) Containers are not reused for other than their designated purpose. Empty herbicide containers are disposed of in accordance with 40 CFR 165.9 Group I & II Containers.

(22) Application equipment, empty herbicide containers, articles of clothing worn during application, and hands or other parts of the body are not rinsed in open water or in wells. Water used to mix or clean up comes from a public water supply and is transported in a separate labeled container.

(23) For broadcast foliar application techniques, workers avoid walking through treated areas on the day of application in alternatives B, C, E, and G.

The purpose of requirements (19), (20), (21), (22), and (23), is to prevent or reduce the risk of accidental contamination of water, clothing, or skin. Monitoring is accomplished through supervisory controls. Modeling in

appendix A shows that subsurface movement of herbicides is negligible. These measures are always effective in further limiting movement. Experience has also shown that proper maintenance of equipment and good hygiene effectively reduce exposure and contamination.

(24) Areas are not prescribed burned for at least 30 days after application of an herbicide in alternatives B, C, E, and G.

The purpose of requirement (24) is to allow time for the herbicide to work in the treated area and to provide maximum protection to workers from herbicide residues in smoke. Experience has shown 30 days to be an effective minimum time for fuels to cure while appendix A shows it to be an effective time lapse to mimimize risk.

Drift Control

(25) Nozzles designed to produce large droplets or streams of herbicide are used to reduce drift potential. Nozzles designed to produce fine droplets (which are subject to drift) are used only for hand application where distance from nozzle to target usually does not exceed 8 feet.

This requirement minimizes risk of off-site contamination from drift of spray droplets. Monitoring is accomplished through supervisory controls. Yates and others (1978) demonstrated that large droplets drift less than small droplets.

Buffers

(26) Known aquifers and public water sources are identified and protected.

(27) Herbicides (unless labeling permits application of the formulation to water) are not aerially applied within 100 feet of lakes, wetlands, or perennial or intermittent springs and streams, nor ground-applied within 30 feet.

(28) When broadcast-applying herbicides, an untreated buffer is left at boundaries with private lands, a 100-foot buffer is left around all water sources, and a 300-foot buffer is left around all private residences in alternatives B, C, E, and G.

(29) Provide sufficient buffering to protect sensitive non-target species where root systems may extend or grow into the active treatment zone when using soil active herbicides.

The purpose of requirements (26), (27), (28), and (29) is to minimize the potential for contamination of water and adjacent lands. Monitoring is done through project plan reviews and on-site supervisory controls. Neary and Michael (appendix C) and Weeks and others (appendix A) determined that buffer strips significantly reduce herbicide concentrations in water.

Spills

(30) Efforts are made to keep spills from entering water and other off-site areas. Spills are cleaned up as quickly as possible. Appropriate Federal, State, and local officials are notified.

This requirement ensures that if accidental spills occur, effects are minimized and proper reporting procedures are followed. Monitoring is done through supervisory controls and incident report reviews. Effectiveness of this mitigation is directly related to size, location, and type of spill, and how quickly it is cleaned up.

d. Biological Method

The following applies to alternatives that use grazing as a biological method. Each forest may be more restrictive but not less.

(1) A site-specific analysis determines how livestock are managed to prevent soil compaction, water contamination, and damage to riparian vegetation and streambanks.

(2) To protect seedlings, grazing as a biological method is excluded from:

(a) longleaf pine stands until seedlings are out of the grass stage and starting height growth;

(b) other pine stands less than age 3 years; and

(c) hardwood stands for at least 5 years after stand establishment.

(3) Trampling damage or browsing of the terminal leaders of desired trees should not exceed 5 percent.

Requirements (1), (2), and (3) protect site values such as soil, water, and desirable vegetation when grazing is used as a biological control. Blackburn (1984) and Patric and Helvey (1986) showed that such controls reduce grazing damage to soil and water. Monitoring is accomplished through project plan reviews and periodic on-site evaluations.

F. COMPARISON OF ALTERNATIVES WITH THE ISSUES

Issues (chapter I) represent expressions of concern by the public, Forest Service managers, and employees. These issues are the foundation for alternatives discussed earlier in this chapter. In this section, we compare the alternatives to see how they respond to the issues (table II-3).

Issues contain many values and are neither positive nor negative. Actually, issues express multiple concerns and

desires, many of which are opposed to each other. Major changes are expected when each alternative is compared with alternative A, the "no action" alternative (table II-3).

Each issue is paraphrased in the following text, and the measure of comparison used in table II-3 is stated.

Balance of resources: Concern is about the mix of resource outputs produced from forests and grasslands. It is believed that an increase in market outputs like timber or an increase in non-market outputs like aesthetics would necessarily be at the expense of the other. The measure of comparison is change in output mix.

Prescribed fire: Such treatments are generally seen as a "natural" process and as necessary for some ecosystems as well as for protection from wildfires. Concern centers on timing, frequency and intensity of use. Comparison measures are availability of fire for fuel and habitat treatments and timing, frequency and intensity.

Health and safety: Concern is that risk of accidents and illness should be evaluated and then minimized for workers, users, and neighbors. Comparison is risk level.

Plant and animal diversity: This concern focuses on potential loss of a species from a site, but an associated concern is effect on hardwoods. Measure of comparison is selectivity of methods used.

Communication: This unique issue has only an indirect relationship to vegetation management activities. Responsiveness to this issue does not depend upon alternatives; therefore it is not in the comparison table. This environmental impact statement is an educational tool, and in part, addresses communication. Further efforts to improve communications are not part of the environmental analysis process but are an integral part of information and education programs.

Cost comparison: A mixture of concerns exist about using least-cost methods as well as being sensitive to employment opportunities. Measures of comparison are per acre treatment costs and employment opportunity.

Soil productivity: People are concerned about erosion, compaction, rutting, and loss of soil organisms. The most direct cause-effect relationship is with intensity of methods which may cause these effects, so the comparison measure is treatment intensity.

Table II-3.—Comparison of alternatives with issues

ALTERNATIVE	ISSUES: Balance of Resources	Prescribed Fire	Health & Safety	Plant & Animal Diversity	Cost Comparison
Comparison Measure	Output mix.	Availability, timing, frequency, intensity.	Risk level.	Method selectivity.	Per acre costs, employment.
A (No Action)	Strongly favors outputs which occur without vegetation manipulation: Favors non-market.	Not available for use.	Eliminates direct risk, increases risk on travelways and from wildfire.	No methods used.	Direct costs and employment opportunity eliminated.
B	Favors non-market outputs, holds market to custodial level.	Very limited availability, low intensity. Timing restricted.	Minimizes direct risk, increases risks from wild-fire.	Few acres treated, methods highly selective.	Direct costs and employment opportunity very low.
C	Favors non-market less than B but more than F.	Limited avail-ability, low intensity. Timing somewhat restricted.	Decreases herbicide and mechanical risks, slight in-crease for wildfire and manual.	Fewer acres treated and methods more selective than F.	Per acre costs lowest, employ-ment lower than F.
D	Does not change the mix of outputs.	Availability same as F, low to moderate intensity. Timing not restricted.	Herbicide risks eliminated, manual and mechanical increase.	Increased use of less selective mechanical and more selective manual.	Cost comparable to F, employ-ment higher.
E	Non-market outputs same as F, market outputs lower or at higher cost.	Greater avail-ability than F, low to moderate intensity. Timing not restricted.	Risks from use of fire and manual increase, herbicide risks decreased.	Substantial in-crease of more selective manual, slight increase in fire use.	Per acre costs comparable to C, employment sub-stantially higher than F.
F	Favors market outputs.	Low, moderate, and high intensity.Tim-ing not restricted.	Risks not minimized, high for manual.	Non-selective methods widely available.	Costs are highest, employment moderate.
G (Preferred)	Maintain market and non-market outputs at current levels.	Somewhat more available than F, low to moderate intensity. Timing not restricted.	Number of exposed individuals in-creases, risk per individual declines. Mechani-cal risks decline.	Mechanical subsantially reduced, herbi-cides increased, and manual slightly increased.	Cost lower than F, employment unchanged.
H	Strongly favors market, decreases non-market outputs.	Widely available. Frequency and intensity increase. Timing not restricted.	All risks increase except manual which decreases.	Substantially increases the use of non-selective methods and tools.	Costs somewhat lower, employment opportunity increases.

ISSUES				
Soil Productivity	Water Quality	Herbicides	Aerial Application	Wildlife
Treatment intensity.	Risk to drinking water.	Tool selectivity, risk.	Availability.	Habitat quality.
No treatments.	No treatments, no risks.	No treatments, no risk.	Not available. improve quality.	No treatments to
Very low intensity.	Minimum treatments, very low risk.	Lowest risk when used, highly selective application tools.	Not available.	No treatments to improve quality, minimum T&E maintenance.
Low intensity.	Risks lower than F from all methods.	Lower risk than F, highly selective tools.	Not available.	Habitat treatments allowed only to maintain populations.
More mechanical treatments, but lower intensity.	Herbicide risk eliminated, other risks lower than F.	No treatments, no risk.	Not available.	Comparable to F, but herbicides not available for habitat treatment.
Fire treatments increase, mechanical decreases, lower intensity.	Herbicide and other risks lower than F.	Much lower risk than F, broadcast application allowed.	Not available.	Comparable to F with decreased use of mechanical treatment.
High intensity methods available.	Moderate risk, mostly mechanical.	Broadcast and selective used.	Not used, deferred.	High intensity methods degrade some habitat.
Fire and herbicide increase, lower intensity than F.	Herbicide risk higher than F, other risks lower.	Use of broadcast leads to less target selectivity.	7,000 acres available.	Reduced mechanical, greater flexibility to protect or improve habitat.
Substantially increased use of high intensity methods.	All risks substantially higher than F.	Highest risk, broadcast application including aerial allowed.	28,000 acres available.	High intensity methods potentially degrade habitat, improvement work increases.

Water quality: Concerns are about potential negative effects on drinking water. Comparison is based on level of risk to drinking water supplies.

Herbicides: One concern is that non-target organisms might be affected, and the other is that there are risks to human health. The measures of comparison are selectivity of treatment tools and level of risk.

Aerial application: Aerial application of herbicides has clearly defined and opposite concerns. One set of interests is concerned that aerially applied herbicides are not selective and will affect many non-targets. Other interests believe that aerial application is an essential tool for economical treatment of some areas. Measure of comparison is availability of aerial application.

Wildlife: Concerns center on wildlife habitat for game, non-game, and threatened and endangered species. One facet of these concerns is about potential negative effects caused by the use of any method. Another equally important facet is managing vegetation to enhance or create more wildlife habitat. The measure of comparison is habitat quality.

G. COMPARISON OF ENVIRONMENTAL EFFECTS

Every alternative has the potential to cause environmental effects. Environmental effects are analyzed in chapter IV. Ways to limit or control these effects are the management requirements and mitigation measures discussed earlier in this chapter. Because each alternative represents a different way to accomplish vegetation management work, effects will also differ.

Makeup of Alternatives

Kinds of effects and their severity or seriousness are determined by several factors:

- Which methods are used?
- Which tools are used?
- How many acres are treated?
- How often (frequency) are treatments applied?

Before reading the evaluation of environmental effects in chapter IV or looking at the comparison of effects between alternatives in table II-8, readers should become familiar with how these factors vary between alternatives. If the factors are understood, then the type and severity of effect will be better understood.

Table II-4 displays methods and tools available for use in each alternative. Each alternative has a unique set of methods and tools. For example, herbicide methods are not available in alternative D, biological methods are not available in alternatives B or F, aerial herbicide application tools are available only in alternatives G and H, and raking tools are only available in alternatives F and H. Careful review will find many other differences.

Table II-5 shows the number of acres treated with each method in each alternative, and lists total acres treated. Total acres range from zero to 801,000. Table II-6 is just another way of expressing data in table II-5 in order to more clearly show how use of each method varies from alternative to alternative. In all alternatives where vegetation management is done, prescribed fire represents a large majority of treatments. Use of other methods varies substantially between alternatives. For example, in alternative E, 2 percent of the total acres are treated with herbicides, while in alternative H, 8.2 percent, or nearly four times as many acres are treated (table II-6). Tables II-5 and II-6 should be used together, however, because total acres treated by all methods vary. Note that in alternative B, 2.7 percent of the acres treated are done with herbicides, yet this is only 3,500 acres. Compare this with alternative E where a lower percentage of acres are treated with herbicides, but total acres treated equals 11,500.

Table II-7 lists frequency of recurring treatments in each alternative. As with the other factors, significant variations exist.

Environmental Effects

Numerous known and estimated environmental effects are discussed in chapter IV which forms the scientific and analytic basis for the comparisons in this section (40 CFR Part 1502.16). Chapter IV discloses effects on each environmental element (such as soil, air, or human health). This section compares how all environmental elements are affected in each alternative. Chapter IV is technical and lengthy. This section summarizes information from chapter IV, and is less technical.

A comparison of the principal environmental effects for each alternative is presented in table II-8. Socioeconomic effects are shown in table II-9.

<u>Human health</u> effects are measured as risk to human health from use of herbicides, and risk of accidental injury from use of vegetation management tools. Indirect effects such as accidents related to wildfire occurrence and suppression are also stated.

Table II-4.—Comparison of alternatives and tools

A	B	C	D
None	Herbicides Hand ground tools Backpack sprayer Spotguns Hypo-hatchets Injectors Axe & sprayer	Herbicides Hand ground tools Backpack sprayer Spotguns Hypo-hatchets Injectors Axe & sprayer	Herbicides None
	Mechanical Low soil disturbance Mowing	Mechanical Low soil disturbance Chopping Mowing Shearing Ripping Scarifying	Mechanical Low to mod. soil disturbance Chopping Mowing Shearing Ripping Scarifying Piling Bedding Light disking
	Manual Moderate amounts Power tools Hand tools	Manual Moderate amounts Power tools Hand tools	Manual Moderate amounts Power tools Hand tools
	Fire Low intensity Dormant season burns Aerial tools Ground tools	Fire Low intensity Dormant and growing season burns Aerial tools Ground tools	Fire Low to moderate intensity Dormant and growing season burns Aerial tools Ground tools
	Biological None	Biological Minor Livestock	Biological Low increase Livestock

Table II-4.—Comparison of alternatives and tools (continued)

E	F	G (Preferred)	H
Herbicides Mechanical ground tools Boom sprayer Granular spreader Hand ground tools Backpack sprayers Spotguns Hypo-hatchet Injectors Axe & sprayer	Herbicides Mechanical ground tools Boom Sprayer Granular spreader Hand ground tools Backpack sprayers Spotguns Hypo-hatchet Injectors Axe & sprayer	Herbicides Aerial tools Helicopter Mechanical ground tools Boom sprayer Granular spreader Hand ground tools Backpack sprayers Spotguns Hypo-hatchets Injectors Axe & sprayer	Herbicides Aerial tools Helicopter Mechanical ground tools Boom sprayer Granular spreader Hand ground tools Backpack sprayers Backpack sprayers Hypo-hatchets Injectors Axe & sprayer
Mechanical Low to mod. soil disturbance Chopping Mowing Shearing Ripping Scarifying Piling Bedding Light disking	Mechanical Low to high soil disturbance Chopping Mowing Shearing Ripping Scarifying Piling Bedding Raking Light disking Heavy disking	Mechanical Low to mod. soil disturbance Chopping Mowing Shearing Ripping Scarifying Piling Bedding Light disking	Mechanical Low to high soil disturbance Chopping Mowing Shearing Ripping Scarifying Piling Bedding Raking Light disking Heavy disking
Manual Moderate to high amounts Power tools Hand tools	Manual Low to moderate amounts Power tools Hand tools	Manual Low amounts Power tools Hand tools	Manual Low amounts Power tools Hand tools
Fire Low to moderate intensity Dormant and growing season burns Aerial tools Ground tools	Fire Low to high intensity Dormant and growing season burns Aerial tools Ground tools	Fire Low to moderate intensity Dormant and growing season burns Aerial tools Ground tools	Fire Low to high intensity Dormant and growing season burns Aerial tools Ground tools
Biological Low increase Livestock	Biological None	Biological Low increase Livestock	Biological Maximum Livestock

Table II-5.--Comparison of acres treated by alternative

Method	A	B	C	D	E	F	G*	H
					Alternative			
Herbicide	0	3,500	17,000	0	11,500	27,000	49,500	65,500
Mechanical	0	12,500	35,500	70,500	35,000	59,000	32,000	64,500
Fire	0	113,500	355,000	464,000	472,000	463,000	466,500	667,000
Manual	0	1,000	6,500	18,000	33,500	4,500	5,000	1,500
Biological	0	0	500	1,000	1,500	0	500	2,500
Total	0	130,500	414,500	553,500	553,500	553,500	553,500	801,000
% Treated**	0	3	9	12	12	12	12	17

**Portion of total 4.6 million acres treated on an annual basis.

Effects on wildlife and aquatic animals are measured as variety of habitats. While direct effects do occur, the indirect effect of alteration of habitat is the most important variable affecting wildlife and fisheries. Habitat is described by successional stage. Where areas are not treated at all, they tend to progress toward later successional stages.

Evaluation of effects on threatened, endangered or sensitive species of plants and animals broadly considers whether or not it is possible to achieve recovery. Recovery is the primary objective of management activities for these species.

Table II-6.--Comparison of method mix (% acres treated) within alternatives

Method	A	B	C	D	E	F	G*	H
					Alternative			
Herbicide	0	2.7	4.1	0	2.0	4.9	8.9	8.2
Mechanical	0	9.5	8.6	12.7	6.3	10.7	5.8	8.1
Fire	0	87.0	85.6	83.8	85.3	83.6	84.3	83.3
Manual	0	0.8	1.6	3.3	6.1	0.8	0.9	0.2
Biological	0	0	0.1	0.2	0.3	0	0.1	0.3

Table II-7--Average treatment frequencies (years) by alternative

Treatment of:	A	B	C	D,E,F,G*	H
Hazard fuels-Coastal Plain	None	5	5	4	3
-Piedmont	None	7	7	6	5
Threatened & Endangered Species Habitat	None	3	2	2	2
Other Wildlife Habitat					
-Coastal Plain	None	None	5	4	3
-Piedmont	None	None	7	6	5
Range	None	None	5	3	2
Trails	None	5	3	1	1
Roads-Forest Service	None	8	4	3	2
-Other	None	3	2	1	1
Utility Lines	None	10	8	6	3
Railroads	None	3	2	1	1
Pipelines	None	4	3	2	1

*Preferred Alternative

Effects on vegetation are generally reflected as changes in species composition. Species composition is the kinds, numbers, and distribution of plants growing on a site. Table II-8 shows effects on woody and herbaceous vegetation and ranks alternatives based on their effects on woody vegetation. Generally, treatments (or lack of treatment) favoring woody vegetation will negatively affect herbaceous vegetation, and conversely.

Alternatives are ranked according to their potential to cause long-term soil productivity losses. Risk of lost soil productivity is based on soil compaction and loss of organic matter, nitrogen, and soil organisms. Such effects may occur from use of prescribed fire, raking, piling, or biological. Effects vary depending on soil type. Alternatives are ranked by determining how much of each treatment is used, and on which soil types.

Two different effects on water are displayed in table II-8. Tons of sediment produced annually means the amount of sediment produced by vegetation management treatments which reaches streams despite mitigation measures. The other effect is the potential for herbicide pollution resulting from typical operations.

Effects on air quality from vegetation management activities result mainly from smoke produced by prescribed fires. Some is also produced by wildfires, and in some alternatives, lack of vegetation management increases the acres burned by wildfire. Table II-8 displays the numbers of acres burned by all types of fires and lists the total tons of smoke produced annually.

Table II-8.—Comparison of environmental effects, by alternative

	Human Health	Wildlife & Aquatics	Threatened, Endangered & Sensitive Species	Vegetation
	Affected Environmental Element			
Comparison Measure(s)	Risks to human health, risks of injury.	Variety of habitats.	Plant and animal species recovery.	Understory species development. Effects on woody species (ranking).
ALTERNATIVE A (No Action)	No direct risks. Risks from wildfire are highest. Lowest overall risk.	Highly favors mid-late successional species. Early successional species restricted to natural disturbances and harvest areas.	Habitat not managed, many species decline. Recovery not likely.	Woody under- and midstory highly favored. No vegetation management after harvest. Intolerant hardwood and pine decline. Ranking = 1 (least effect)
B	Very low risk to human health from herbicides, and very low risk of injury. Risk from wildfire high.	Favors mid-late successional species slightly less than A. Early successional habitat more available than A.	Known populations maintained, but recovery not likely.	Woody under- and midstory highly favored, but less than A. Herbaceous understory favored only on corridors, fuel tmt or T&E areas. Ranking = 2.
C	Herbicide risks are low; though greater than B, risks are less than F. Risk of injury moderate for manual and mechanical.	Favors mid-late successional species, but less than B. More early successional species habitat than B, but less than D.	Recovery of known populations is likely.	Woody under- and midstory moderately favored. Selective herbicide tools, low intensity fire, increased manual, low disturbance mech. favor woody understory. Ranking = 3.
D	No herbicide risk. Accident risk very high for mechanical, high for manual, and moderate for prescribed fire.	Favors early successional stage species due to high use of mechanical and growing season burns.	Recovery of known populations is likely.	Woody under- and midstory reduced, but less than F. Use of mechanical, low-moderate intensity burns favor herbaceous understory. Ranking = 6.
E	Herbicide risk is about the same as B; program is larger than B but safer methods are used. Accident risk is high for mechanical, moderate for others.	Mixed early, mid and late successional habitats, but very early stage is limited. Use of manual favors mid-late species.	Recovery of known populations is likely.	Woody under- and midstory slightly favored. Use of less mechanical and increased manual favor woody understory. Ranking = 4.
F	Current level of exposure to herbicides; greater than B, C, & E less than G & H. Accident risk high for mechanical, moderate for other methods.	Mixed early, mid and late successional habitats. High intensity fire, mech. & herbicide use favor early successional species.	Recovery of known populations is likely.	Woody under- and midstory reduced. Broadcast herbicides, low-high mech. disturb., low-high burn intensity favor herb. understory. Ranking = 7.
G (Preferred)	More individuals exposed than in F but selection and mitigation of herbicides reduces individual risk (less than F). All accident risks are moderate.	Mixed early, middle and late successional habitats. Broadcast herbicides, mech., and growing season burns slightly favor early-mid successional species	Recovery of known populations is likely.	Woody under- and midstory reduced, more than E but less than F. Broadcast herbicides, mechanical disturb., fire intensity slightly favor herb. understory. Ranking = 5.
H	Highest risk of accidents from all methods except manual. Mitigated risk from operational use of herbicides remains low, but highest of all.	Highly favors early successional stage species.	Recovery of known populations is likely.	Highest reduction of woody under- and midstory. Increased broadcast herbicides, mech. disturb., fire intensity highly favor herb. understory. Ranking = 8 (most effect).

Table II-8.—Comparison of environmental effects, by alternative (continued)

Affected Environmental Element				
Soil	Water	Air	Visual Quality	Cultural Resource
Risk of long-term soil productivity loss.	Tons of sediment produced annually. Risk of herbicide pollution, typical operations.	Acres burned. Tons of smoke produced annually.	Visibility of work. Meets VQO's.	Risk of loss damage.
Low to moderate risk due to widespread, intense wildfires.	Wildfires produce significant sediment. No risk of herbicide pollution.	Slash burns = 0, underburns = 0, Wildfires = 120,000 ac. producing 73,900 tons of smoke.	No work done. VQO's not met for vistas, developed recreation sites, or other areas requiring manipulation.	Lowest - though wildf may damage architectura resources.
Low risk due to some intense wildfires.	Wildfires produce some sediment. Treatments produce 100 tons. Negligible risk of herbicide pollution.	Slash burns = 0, underburns = 114,000 ac., wildfires = 81,000 ac. producing 48,000 tons of smoke.	Work generally not visible. VQO's may be met.	Low - wildfi may damage architectura resources.
Lowest risk due to restricted use of low disturbance tools.	Treatments produce 620 tons of sediment. Negligible risk of herbicide pollution.	Slash burns = 9,000 ac., underburns = 346,000 ac., wildfires = 15,000 ac. producing 41,100 tons of smoke.	Work less visible than present. VQO's may be met.	Low.
Low risk, 21% more than C, due to use of low to moderate disturbance tools.	Treatments produce 1,050 tons of sediment. No risk of herbicide pollution.	Slash burns = 18,000 ac., underburns = 447,000 ac., wildfires = 12,000 ac. producing 45,200 tons of smoke.	Less browning visible than F, but overall visibility comparable. VQO's may be met.	Moderate.
Low risk, 14% more than C, due to use of low to moderate disturbance tools.	Treatments produce 660 tons of sediment. Negligible risk of herbicide pollution.	Slash burns = 25,000 ac., underburns = 447,000 ac., wildfires = 12,000 ac. producing 46,900 tons of smoke.	Visibility comparable to present. VQO's may be met.	Moderate.
Moderate risk, 4.3 times that of C, due to some use of high disturbance tools.	Treatments produce 1,610 tons of sediment. Negligible risk of herbicide pollution.	Slash burns = 13,000 ac., underburns = 451,000 ac., wildfires = 12,000 ac. producing 44,500 tons of smoke.	High visibility, significant disruptions. VQO's may be met.	High
Low risk, 4% more than C, due to use of low to moderate disturbance tools.	Treatments produce 1,030 tons of sediment. Some risk of herbicide pollution.	Slash burns = 20,000 ac., underburns = 447,000 ac., wildfires = 12,000 ac. producing 45,100 tons of smoke.	Similar visibilty to present, but of shorter duration. VQO's may be met.	Moderate
Highest risk, 11.6 times that of C, due to emphasis on high disturbance tools.	Treatments produce 3,160 tons of sediment. More risk herbicide pollution.	Slashburns = 8,000 ac., underburns = 660,000 ac., wildfires = 9,000 ac. producing 51,200 tons of smoke.	Foreground and middleground strongly influenced by work. May not meet VQO's.	Highest

Visibility of work and achievement of visual quality objectives are two measures of effects on visual quality. Whether or not vegetation management work can be seen by the average user depends largely upon how many acres are treated and where the work is located. An additional factor contributing to visibility is intensity of work. Visual quality objectives (VQO's) are goals for desired visual conditions which have been established for all landscapes.

An estimate of risk of damage or loss is used to state effects on cultural resources. Damage or loss is most likely to occur wherever the ground is disturbed. Some cultural resources may also be affected by fire. Generally, effects from ground disturbance increase with depth of penetration by the tool being used, and with soil displacement. Risks related to fire increase with increased wildfire occurrence, but not with increased use of prescribed fire.

Economic and Social Effects

Economic and social effects are in table II-9. Six types of effects are shown.

Total cost reflects the annual expenditure necessary to accomplish the vegetation management program. It is calculated by determining the cost of using each method for each activity proposed, and multiplying by the number of acres treated.

Cost per acre is actually an average cost determined by dividing total cost by total acres treated. Average costs are influenced by methods used for treatment, as some methods are more costly than others.

Indirect costs are also sometimes called opportunity costs and they are extremely difficult to quantify. It is also not always easy to determine who pays these costs. For example, if good silvicultural practices aren't used, sites won't produce wood products to their capability. This results in lower harvest volumes, thus lower receipts to the treasury. But, lower receipts result in lower payments to counties, which in turn often results in higher taxes to maintain services. Another example is that low or no maintenance of rights-of-way causes damage to facilities within them. For an electric transmission line, the utility company spends more for repairs, but these additional costs are passed on to consumers and shareholders.

Outputs are classed as managed or unmanaged. While most outputs such as wildlife, timber, recreation, and forage require some form of management, there are some like wilderness or late successional species which occur in the absence of vegetation manipulation.

Table II-9.--Effects of alternatives on socioeconomics

Alternative	Total Cost	Cost/ Acre	Indirect Cost	Outputs	Expectations	Employment
A No Action	N/A	N/A	Highest	Favors unmanaged	Favors primitive	Lowest
B	$ 2,028,000	$15.54	Much higher than current	Favors unmanaged	Favors primitive	Much lower than current
C	5,972,000	14.40	Higher than current	Favors unmanaged but allows minimum managed	Favors primitive to semi-primitive	Higher than B but lower than current
D	8,757,000	15.82	High for non-herbicide use	Comparable to current	Favors semi-primitive but allows all settings	Higher than current but lower than E
E	7,992,000	14.43	Comparable to C	Slightly lower than current	Comparable to C	Highest
F	8,802,000	15.90	Moderate	Favors both managed & unmanaged	Allows all, but most acres in semi-primitive/ roaded natural	Moderate
G Preferred	8,366,000	15.11	Lower than current	Comparable to current	Comparable to current but more emphasis toward semi-primitive non-motorized/ primitive	Comparable to current
H	12,618,000	15.75	Lower than current	Favors managed	Favors roaded natural/ rural	Higher than current

User expectations cover a range from primitive to rural settings. These settings are explained in chapter III. Generally, as more vegetation treatments are done, more expectations toward the rural end of the scale can be met.

Employment opportunity is stated qualitatively (low to high), and reflects only those jobs directly associated with vegetation management. Numbers of jobs available depend on the labor intensity of methods used and numbers of acres treated. Manual methods are the most labor intensive.

H. SUMMARY OF COMPARISON OF ALTERNATIVES

Alternative A has the lowest risk of many effects because no vegetation management is done. There are no herbicides used, so there is no risk of adverse **health effects** or **water pollution** from them. An increase in acres and intensity of wildfires creates a substantial risk of **injury** to firefighters, users, and neighbors. Mid to late successional **wildlife** species such as gray squirrel increase over present levels, but early successional species such as quail decline significantly. Many populations of **threatened, endangered, and sensitive** plant and animal species cannot recover, and fire-dependent species such as gopher tortoise decline. Woody **vegetation** thrives while herbaceous vegetation and shade-intolerant plants decline. There is a low to moderate risk of reduced **soil productivity** from intense wildfires, and no treatment-caused **sediment** is produced. **Air quality** is impaired more in this alternative than any other, due to the high acreage burned by wildfire. **Visual quality** is not impaired by vegetation treatments, but areas like vistas which require treatment cannot be maintained. Risks to **cultural resources** are extremely low, but damage from wildfire occurs. No funds are expended for vegetation management, but indirect **costs** are highest. Facilities within rights-of-way deteriorate and some are abandoned. Growth and yield of pines, hardwoods, and forage decline in proportion to the amount of competition. Resource and property damage from wildfires are high. **Revenue** and returns to counties decline over time and are the lowest of all alternatives. All managed **outputs** decline. Forest Land and Resource Management Plan objectives cannot be achieved. Primitive and semi-primitive **settings** increase substantially over time, while other settings decline. There is no **employment** provided by vegetation management.

Alternative B has a very low risk of many effects because vegetation management is conducted on a limited scale, only to protect resources such as threatened, endangered, and sensitive species or health and safety. Risk to **human health** from herbicides are very low but higher than A or D. Limited use of other methods also means a very low risk of accidental **injury** exists. Wildfires are more widespread than currently, so the risk to firefighters, users, and neighbors is higher. Effects on **wildlife** are comparable to alternative A, except where treatments for corridors, threatened, endangered, and sensitive species, and hazard fuels are done more early successional habitat for species

such as Eastern meadowlark is available. Known populations of **threatened, endangered, and sensitive** species are maintained but recovery is not likely because little, if any, additional habitat is created. Effects on **vegetation** are similar to alternative A. Where treatments are done, more herbaceous species are favored. Only low-intensity methods are used so effects on **soil productivity** and **water quality** are low and occur only from intense wildfires. **Smoke** production is higher than most alternatives, but greatly reduced from alternative A. There is little noticeable difference in **visual quality** between this alternative and A. Work can be done on vistas and other areas needing treatment, so visual quality objectives are met. Risks to **cultural resources** are comparable to A. Risk from wildfires is reduced, but significantly higher than current. This alternative has the lowest total program **cost,** but per acre costs are higher than alternatives C, E, or D. Indirect costs are comparable to A (very high). Facilities in rights-of-way are costly to maintain, but are not abandoned unless abandonment is less costly than emergency maintenance. Revenue and returns to counties become very low over time, only slightly higher than alternative A. Unmanaged **outputs** are strongly favored, but managed output levels benefit from treatments done. Forest Land and Resource Management Plan objectives cannot be achieved. Primitive and semi-primitive **experiences** are favored. Most treated areas provide semi-primitive experiences, with few being semi-primitive motorized. **Employment** opportunities are far lower than current, and only somewhat higher than alternative A.

<u>Alternative C</u> treats about three times as many acres as alternative B, 80 percent as many acres as D, E, F, or G, and about half as many acres as H. Treatment methods and tools are selected to provide target-specific control. Risk to **human health** from herbicides is low for workers, though higher than alternative B. Risk to the public is very low. Manual and mechanical methods are used more extensively than in alternative B, so **accident** frequencies are higher, though very comparable to current for manual. Mid to late successional **wildlife** species such as gray squirrel are favored. The number of acres treated creates more early successional habitat for species such as mourning dove than alternative B, less though than alternatives D, E, F, G, or H. **Threatened, endangered, and sensitive** species are able to recover. Woody species are favored, with low intensity tools favoring woody **understory.** Risk of lost **soil productivity** is lowest and sediment production is very low. Selectivity of herbicide application techniques minimizes potential **water** pollution. **Smoke** production is lowest in this alternative. Wildfire incidence is reduced (compared to A and B) to nearly current levels. Work is more visible

than in alternative B because more acres are treated, but target specific controls cause fewer impacts than present. **Visual quality** objectives may be met. Risk of loss or damage of **cultural resources** is lower than D, E, F, G, or H. Total program **costs** are lower than present, though nearly three times the cost of alternative B. Per acre treatment costs are lowest, comparable to alternative E. Indirect costs are significantly lower than alternatives A or B, but remain high due to reduced effectiveness of some treatments. Both managed and unmanaged **outputs** are gained, but unmanaged outputs are favored. Forest Land and Resource Management Plan goals and objectives cannot be achieved, but are more nearly achieved than in A or B. Primitive and semi-primitive **experiences** are favored, as in alternative B, but more motorized experiences are possible. **Employment** is significantly increased compared to B, but remains below current levels.

Alternative D does not use herbicides, so risk to **human health** and **water quality** from herbicides does not exist. Because other methods are used in place of herbicides, risks of accidental **injury** are very high. Early successional **wildlife** such as mourning dove are favored by the use of mechanical methods and growing season burns. **Threatened, endangered, and sensitive** species are able to recover. Effects on woody **understory** are greater than alternatives A, B, C, and E. Herbaceous understory is favored by mechanical and prescribed fire use. Risk of lost **soil productivity** is about 21 percent greater than alternative C, but 72 percent less than F. **Sediment** produced is higher than in alternative A, B, C, or E, but far less than current. The amount of **smoke** produced is about the same as F. **Visibility** of work is about the same as current, but the browning effect caused by herbicide treatments is absent. Visual quality objectives may be met. Risks of loss or damage to **cultural resources** are moderate compared to A and B because mechanical methods are used. Total program **costs** are only slightly lower than current. Indirect costs are incurred whenever herbicides would have been more cost-effective, or when more frequent treatments are needed. **Outputs,** managed and unmanaged, vary little from current levels. **Experiences** can be had in all settings, with more semi-primitive settings than current. More **employment** opportunities than currently available are offered.

Alternative E stresses the use of manual methods and prescribed fire. The number of acres treated with herbicides is less than half the current level. **Human health risk** to workers is only slightly greater than alternative B. Human health risk for the public is very low. **Accidental injuries** from manual operations are very high, while accidents from other operations are generally lower than current. All successional habitat stages are provided

for **wildlife**, however, wherever manual treatments are done, mid to late successional species such as gray squirrel are favored. **Threatened, endangered, and sensitive** species are able to recover. **Woody species** are slightly favored over herbaceous species, especially where less mechanical or more manual treatments are used. Risks of lost **soil productivity** are 14 percent higher than alternative C, and 73 percent lower than F. **Sediment** production is far lower than present and comparable to alternative C. Risks of **water** pollution from herbicides is very low. **Smoke** production is slightly higher than current, but less than alternative B. There is little difference in **visual quality** between this alternative and F. Visual quality objectives may be met. Risks to **cultural resources** are moderate, less than current, due to fewer mechanical treatments. Total program **costs** are about 10 percent less than current. Costs per acre are comparable to the lowest per acre costs realized in alternative C. Indirect costs are comparable to alternative C, due principally to reduced effectiveness (duration of effect) of some treatments. Though managed and unmanaged **outputs** are produced, managed output levels are slightly lower than current. Types of **experiences** are comparable to alternative C where primitive to semi-primitive settings dominate. **Employment** opportunities are highest, due to widespread use of labor intensive methods.

<u>Alternative F</u> is the current level of treatment specified in Forest Land and Resource Management Plans. Risk of adverse **health** effects from herbicides is low for workers and the public. Risks to workers, though low, increases when treatments are done with backpack sprayers. Risk of exposure is lower in this alternative than in G or H. Risk of accidental **injury** is high where manual methods are used, and moderate for other methods. **Wildlife** habitat is mixed for early, mid and late successional species. Where high intensity treatments are done, early successional species such as mourning dove and deer are favored. **Threatened, endangered, and sensitive** species are able to recover. Effects on woody **vegetation** are more severe than any other alternative except H. Herbaceous understory is favored. Risk of lost **soil productivity** is higher than alternatives D, E, or G. **Sediment** production is one-half that of alternative H, but is higher than all other alternatives. **Smoke** production is slightly lower than alternatives D, E, or G. Vegetation treatments are often highly **visible** and exhibit significant disruptions. Visual quality objectives may be met. Risk of potential loss or damage of **cultural resources** is higher than all other alternatives but H. Total program **costs** are comparable to alternative D, and about 5 percent higher than alternative G. Per acre costs are also comparable to alternative D, but are highest of all. Indirect costs exist and are considered moderate when

compared to other alternatives. Managed and unmanaged **outputs** are both produced from areas allocated to specific uses, with managed outputs favored. The full range of **experiences** is available, from primitive to rural, but most settings are semi-primitive or roaded natural. **Employment** levels are considered moderate when compared to other alternatives.

Alternative G introduces the use of aerial application of herbicides and moderates the intensity of other methods. More people are **exposed** to herbicides than in F, however, use of safer herbicides and additional mitigation increases individual **safety**. Risk of overall accidental **injury** is slightly higher than F, but much lower for mechanical. A mixture of early, mid and late successional **wildlife** habitats is available. Early to mid successional stages are favored where broadcast herbicides, mechanical treatments, or growing season burns are used. **Threatened, endangered, or sensitive** species are able to recover. Effects on woody **vegetation** are reduced from current levels. Herbaceous vegetation is favored where broadcast herbicides, mechanical, or moderate intensity prescribed burns are used. Risk of **soil productivity** loss is less than D or E. **Sediment** production is slightly lower than alternative D and about 35 percent lower than current. **Smoke** production is comparable to alternatives D, E, and F. Treatments are as visible as they are currently, but effects don't last as long. **Visual quality** objectives may be met. Reduced use of mechanical methods reduces the risk to **cultural resources** compared to F. Total program **costs** are about 5 percent lower than current, and per acre costs are lower than alternatives B, D, F, and H. Indirect costs are somewhat lower than current, principally due to the availability of aerial application techniques. **Output** mixes are about the same as current, though some opportunity exists for unmanaged outputs to increase due to lower intensity treatments. **Experiences** cover the range of settings as in F, but settings nearer the primitive end of the scale are slightly more favored. **Employment** opportunities are similar to current, with some potential for a few more jobs in manual treatments.

Alternative H treats more acres than any other alternative (45 percent more than current) to achieve maximum competition control. Risks to **human health** from herbicides are low, but higher than any other alternative due to the larger number of acres treated. Risk of accidental **injury** from manual is very low, but risk of injury from other methods is higher than for any other alternative. Earlier successional stage **wildlife** such as mourning dove are highly favored. **Threatened, endangered, and sensitive** species attain recovery. This alternative has the greatest effect

on woody **vegetation.** Herbaceous vegetation is highly favored by more intensive treatments. Risk of lost **soil productivity** is highest, nearly 3 times the risk of alternative F. **Sediment** production is also double that in F. **Smoke** production is higher than for alternatives B, C, D, E, F, or G, due to more prescribed burning, but wildfire acreage is less than current levels, keeping smoke production below alternative A. **Visual quality** is strongly influenced in the foreground and middleground, so work is highly visible. Visual quality objectives may not be met. Extensive use of mechanical treatments in this alternative creates the highest risk of damage or loss of **cultural resources,** though mitigation measures keep these effects from being significant. Total program **costs** are highest of all, and per acre costs are in the high range, but slightly lower than current. Indirect costs are lower than current for most outputs, except that non-market outputs may be lost as market outputs are stressed. Often, non-market **outputs** are unmanaged, and this alternative deemphasizes unmanaged outputs. Forest Land and Resource Management Plan objectives are generally not met, especially for non-market outputs. **Experiences** in roaded natural and rural settings are favored. **Employment** is higher than all alternatives except E.

Aerial Application

Two alternatives, G and H, include the use of **aerial application of herbicides** by helicopter. This technique reduces worker exposure but increases potential for offsite drift and accidental water contamination due to overflight of active streams. Alternative G aerially treats 7,000 acres, or about 14 percent of the herbicide program. Most of these are for rights-of-way maintenance and some are for site preparation. Alternative H expands use of aerial application and treats 28,000 acres (about 43 percent of the herbicide program). Most of these are for site preparation and rights-of-way, but some are for release work. Mitigation measures including the use of low drift delivery systems and buffer strips along streams are designed to reduce risk of water contamination or offsite drift.

Aerial application of herbicides is currently suspended by the Chief of the Forest Service. Aerial application by helicopter is analyzed in alternatives G and H. If the Record of Decision includes aerial application, the Regional Forester will request the suspension be lifted prior to using aerial methods.

I. IDENTIFICATION OF PREFERRED ALTERNATIVE

Alternative G is the Forest Service's preferred alternative.

Affected Environment

CHAPTER III

CHAPTER III

AFFECTED ENVIRONMENT

IN BRIEF

Part A describes the geographic area analyzed and gives a general description of physiography and climate. Part B gives more detailed descriptions of facets of the environment that may be affected by proposed activities.

A. PHYSICAL AND BIOLOGICAL SETTING

This environmental impact statement relates to national forests and national grasslands in the Coastal Plain/Piedmont (table III-1). These lands total 4.6 million acres in eight states.

Table III-1.--Administrative units covered by the EIS

STATE	NATIONAL FOREST - NATIONAL GRASSLAND
Alabama	Conecuh, Tuskegee, Talladega (Oakmulgee Div.)
Florida	Apalachicola, Choctawhatchee, Ocala, Osceola
Georgia	Oconee
Louisiana	Kisatchie
Mississippi	Bienville, Delta, DeSoto, Holly Springs, Homochitto, Tombigbee
North Carolina	Croatan, Uwharrie
South Carolina	Francis Marion, Sumter(except Andrew Pickens District)
Texas	Angelina, Davy Crockett, Sabine, Sam Houston; and Caddo and Lyndon B. Johnson National Grasslands

All or parts of 23 national forests and two national grasslands are covered. These units are managed by eight Forest Supervisors, one in each State.

1. Physiography

The South contains five physiographic divisions (figure III-1). This EIS covers the Coastal Plain/Piedmont.

The Coastal Plain is part of the Continental Shelf that has been raised above sea level. It lies on young sediments deposited by ocean and river currents. Altitude is 0-600 feet. The varied landscapes compose three broad zones:

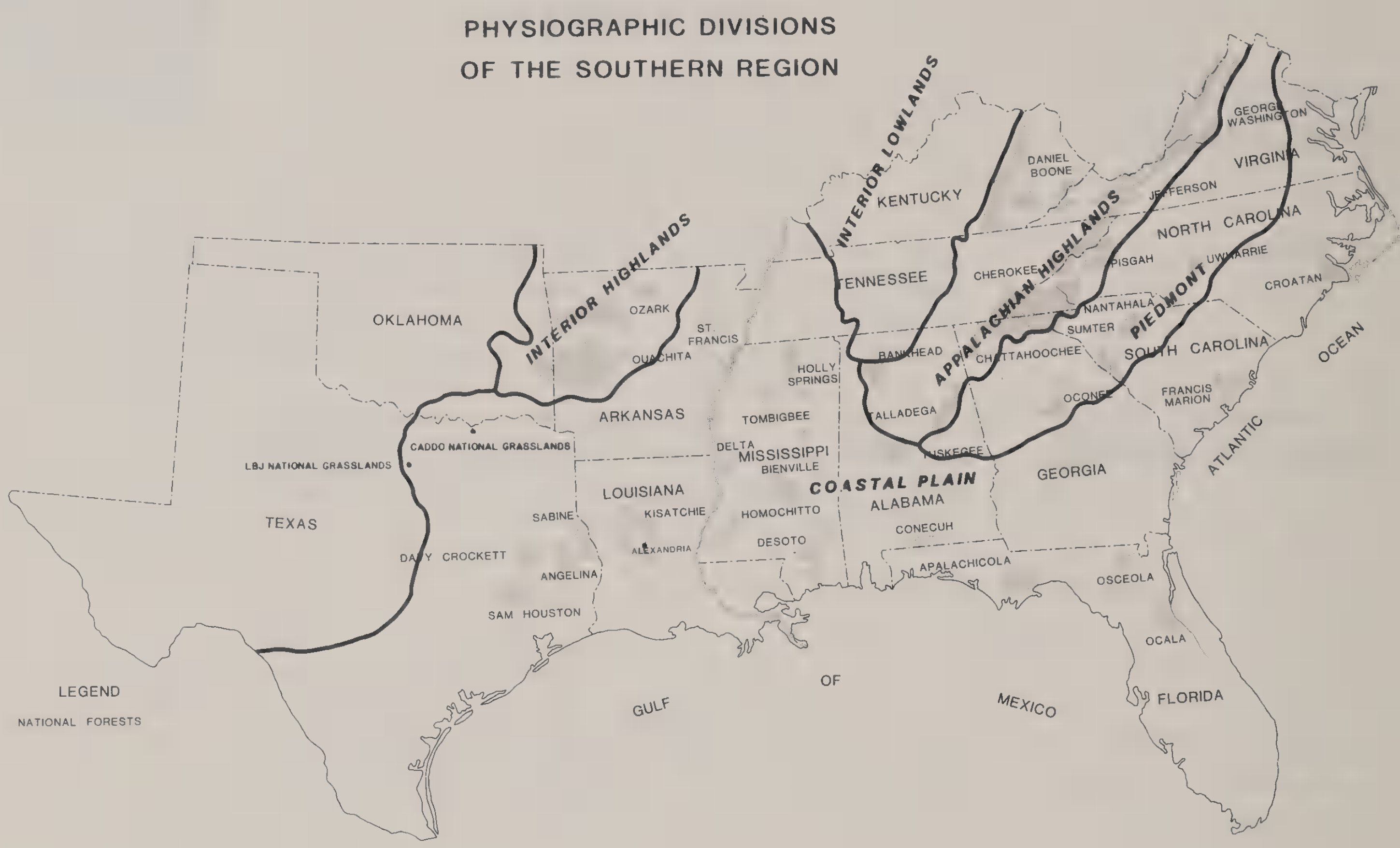


Figure III-1.--Physiographic subregions and States in the Forest Service's Southern Region.

(1) The Upper Coastal Plain is an interior belt of sandy hills bordering the Piedmont. Topography is rolling to hilly and is sharply dissected by stream channels. Landtypes in this zone are the sand hills and upper hills.

(2) The Middle Coastal Plain is a broad expanse of rolling, sandy and loamy uplands broken by narrow belts of clay lowlands and river valleys. Landtypes in this zone include the cross timbers, clay prairies, clay lowlands, rolling uplands, and loess uplands.

(3) The Lower Coastal Plain includes the Mississippi Valley, flatwoods along the Atlantic and Gulf coasts, and Florida. Topography is flat and little dissected. High water tables and wetlands are common in the Mississippi Valley and flatwoods. Sand ridges and lakes are common in central Florida.

The Piedmont is a rolling to hilly upland on old, deeply weathered metamorphic and igneous rocks. Formerly a rugged highland, it was worn by erosion to a dissected plateau that slopes gently from the Appalachians to the Coastal Plain. Streams have carved narrow valleys among broad ridges and slopes. Abusive farming from 1800 to 1940 caused severe soil erosion. Altitude is 500 to 1500 feet.

2. Climate

The Coastal Plain/Piedmont has a humid subtropical climate with hot, humid summers and mild winters. Gulf and Atlantic air masses dominate the weather. Thunderstorms are frequent in spring and summer. Hurricanes occasionally strike the coast, bringing torrential rains. Winter precipitation is caused by frontal systems.

Precipitation averages 45-60 inches per year and falls 90-120 days per year. Even the driest summer month receives at least 1.2 inches of rain. Spring and summer droughts do occur, however, and fall is commonly the driest season. Thunderstorm activity, total rainfall, and rainfall intensities are highest along the Gulf Coast.

Average annual temperature is 60-70° F. July temperatures range from highs of 90-95° F to lows of 65-75° F. January temperatures have ranges of 35-55° F in the Piedmont and 50-70° F in Florida. The growing season is 200-300 days, but frost occurs nearly every winter. Snow falls rarely and melts quickly. Relative humidity averages 70-75 percent.

B. ENVIRONMENTAL ELEMENTS

1. Vegetation

a. Forest

Over the years several classification systems have been developed to categorize and group tree species. These systems have focused singularly or in combination on climatic, geographic, historic, and/or potential (biological) vegetation occurrence. Of the many systems developed, three commonly used are Braun's (1950) description of forest regions, Kuchler's (1966) potential natural vegetation, and Bailey's (1980) ecoregions. This description of the Coastal Plain/Piedmont uses Kuchler's (1966) potential natural vegetation units. Since no one system necessarily details many examples within the overstory, midstory, and understory of forests, examples of some common woody and herbaceous species have been added.

Three broad forest vegetation categories are dominant in the Coastal Plain/Piedmont:

(1) Oak-hickory-pine forests, covering approximately 77 million acres (Federal, State, and private ownerships) are the most widespread. Many people recognize these as loblolly-shortleaf-hardwood forests. They are interspersed throughout all three Coastal Plain landscape zones, and comprise the majority of all forested areas in the Piedmont from North Carolina to east Texas. These forests are recognized as containing mixtures of both pine and hardwood species. Braun (1950) classified these forests to be within parts of the oak-hickory, southeastern evergreen, and oak-pine forest regions, and Bailey (1980) classified them as part of the Southeastern Mixed Forest Province.

Loblolly, shortleaf, and to a much lesser extent Virginia pine, predominate. While hardwoods are codominant with pine throughout much of the area, significant hardwood mid- and understories are characteristic of these forests. Most common are species of oak and hickory, along with dogwood, persimmon, sweetgum, elm, redcedar, yellow poplar, black tupelo, and red maple. Shrubs and vines common to these forests include American beautyberry, hawthorns, hollies, blueberries, viburnums, greenbriers, blackberry, yellow jessamine, honeysuckle, and grape. A more comprehensive list of woody species representative of the oak-hickory-pine forests is found in table III-2.

(2) Southern mixed and sand pine scrub forests, covering approximately 19 million acres (Federal, State, and private ownerships), border the Atlantic and Gulf coasts from South Carolina to east Texas. These are more commonly known as longleaf-slash pine forests. They generally occupy the lower and middle Coastal Plain landscape zones. Braun (1950) classified these forests as part of the Southeastern evergreen forest region, and Bailey (1980) as part of the Outer Coastal Plain Forest Province.

Small amounts of loblolly and shortleaf pine do occur in these forests, but longleaf and slash pine predominate. Sand pine is unique to this grouping and occurs only in Florida and southeast Alabama.

Where fire has been excluded from these forests, a heavy understory of volatile evergreen hardwood species such as palmetto and gallberry commonly occur. Other tree species associated with longleaf-slash pine forests include turkey oak, bluejack oak, blackjack oak, myrtle oak, live oak, holly, titi, cabbage palmetto, and southern magnolia. Shrubs and vines common to these forests include rosemary, youpon, saw palmetto, scrub palmetto, runner oak, sand post oak, wax myrtle, gallberry, staggerbush, St. Andrews cross, gopher apple, and greenbriers.

Table III-2.--Some representative woody species of oak-hickory-pine forests

Trees:

Common Name	Scientific Name	Common Name	Scientific Name
Red Maple	*Acer rubrum*	Red Bay	*Persea borbonia*
American hornbeam, Ironwood	*Carpinus caroliniana*	Shortleaf pine	*Pinus echinata*
		Loblolly pine	*Pinus taeda*
Bitternut hickory	*Carya cordiformis*	Virginia pine	*Pinus virginiana*
Pignut hickory	*Carya glabra*	Black cherry	*Prunus serotina*
Shagbark hickory	*Carya ovata*	White oak	*Quercus alba*
Mockernut hickory	*Carya tomentosa*	Scarlet oak	*Quercus coccinea*
Eastern redbud	*Cercis canadensis*	Southern red oak	*Quercus falcata*
Flowering dogwood	*Cornus florida*	Blackjack oak	*Quercus marilandica*
Common persimmon	*Diospyros virginiana*	Water oak	*Quercus nigra*
American beech	*Fagus grandifolia*	Willow oak	*Quercus phellos*
White ash	*Fraxinus americana*	Chestnut oak	*Quercus prinus*
Eastern redcedar	*Juniperus virginiana*	Northern red oak	*Quercus rubra*
Sweetgum	*Liquidambar styraciflua*	Shumard oak	*Quercus shumardii*
Yellow-poplar	*Liriodendron tulipifera*	Post oak	*Quercus stellata*
Red mulberry	*Morus rubra*	Black oak	*Quercus velutina*
Black tupelo, Blackgum	*Nyssa sylvatica*	Sassafras	*Sassafras albidum*
Eastern hophornbeam	*Ostrya virginiana*	Winged elm	*Ulmus alata*
Sourwood	*Oxydendrum arboreum*		

Shrubs and Vines:

Common Name	Scientific Name	Common Name	Scientific Name
Serviceberry	*Amelanchier arborea*	Blackberry	*Rubus* spp.
American beautyberry	*Callicarpa americana*	Saw greenbrier	*Smilax bona-nox*
Fringetree	*Chionanthus virginicus*	Cat greenbrier	*Smilax glauca*
Hawthorns	*Crataegus* spp.	Common greenbrier	*Smilax rotundifolia*
Yellow jessamine	*Gelsemium sempervirens*	Common sweetleaf	*Symplocus tinctoria*
Winterberry, possumhaw	*Ilex decidua*	Sparkleberry	*Vaccinium arboreum*
American holly	*Ilex opaca*	Deerberry	*Vaccinium stamineum*
Japanese honeysuckle	*Lonicera japonica*	Dryland blueberry	*Vaccinium vacillans*
Virginia creeper	*Parthenocissus quinquefolia*	Arrowwood	*Viburnum dentatum*
		Possumhaw viburnum	*Viburnum nudum*
Shining sumac	*Rhus copallina*	Summer grape	*Vitis aestivalis*
Smooth sumac	*Rhus glabra*	Muscadine grape	*Vitis rotundifolia*
Poison ivy	*Rhus radicans*	Rusty blackhaw	*Viburnun rufidulum*
Poison oak	*Rhus toxidodendron*		

Forests that receive periodic prescribed burns are primarily comprised of herbaceous understories dominated by grasses (see range vegetation discussion). The same hardwood tree, shrubs, and vine species occur in the prescribed burned areas as in unburned areas, but these species are generally limited to the lower, wetter portions of fire-managed forests. A more comprehensive list of woody species representative of longleaf/slash pine forests is found in table III-3.

(3) Southern floodplain (bottomland) and pocosin forests, covering approximately 29 million acres (Federal, State, and private ownerships) are interspersed throughout the entire Coastal Plain/Piedmont and are common within the loblolly-shortleaf and longleaf-slash pine forest categories. Bottomland forests have been categorized by Braun (1950) to be within the oak-pine and southern evergreen forest regions. In Bailey's (1980) ecoregions bottomland forests are within both the Southeastern Mixed and Outer Coastal Plain Provinces.

These bottomland or floodplain forests occupy areas along streams, rivers, lake shores, and in bays, ponds, sloughs, hammocks, bayous, and swamps. Many of these areas are subject to periodic flooding. Common tree species include red maple, sugarberry, river birch, sweetgum, water hickory, black tupelo, American elm, sycamore, cottonwood, cherrybark oak, water oak, willow ash, and baldcypress. Shrubs and vines include buttonbush, swamp privet, fringetree, strawberry bush, possumhaw, trumpet creeper, Japanese honeysuckle, and greenbriar. A more comprehensive list of woody species representative of southern bottomland forests is found in table III-4.

b. Range

Range within the Coastal Plain/Piedmont is divided into five vegetation-cover categories: natural grassland, wet meadow, brush, conifer, and hardwood overstory cover.

Grasslands are naturally occurring open areas of lower precipitation where herbaceous species are dominant. They receive less precipitation than forest land but greater than that of desert land. Annual and perennial grasses, along with sedges and forbs, are the major herbaceous species in grasslands. Woody species are generally absent except for scattered shrubs or trees along rivers and streams. On the national grasslands in Texas, part of the original tall grass prairie, common dominant grasses include switchgrass (*Panicum virgatum*), Indian grass (*Sorghastrum nutans*), big bluestem (*Andropogon gerardii*), and little bluestem (*Schizachyrium scoparium*).

Table III-3.--Some representative woody species of southern mixed forests

Trees:

Common Name	Scientific Name	Common Name	Scientific Name
Florida maple	Acer barbatum	Shortleaf pine	Pinus echinata
Red maple	Acer rubrum	Slash pine	Pinus elliottii
American hornbeam, Ironwood	Carpinus caroliniana	South Florida slash pine	Pinus elliottii var. densa
Pignut hickory	Carya glabra	Longleaf pine	Pinus palustris
Mockernut hickory	Carya tomentosa	Loblolly pine	Pinus taeda
Titi, Buckwheat-tree	Cliftonia monophylla	White oak	Quercus alba
Flowering dogwood	Cornus florida	Chapman oak	Quercus chapmanii
Titi, swamp cyrilla	Cyrilla racemiflora	Southern red oak	Quercus falcata
Common persimmon	Diospyros virginiana	Bluejack oak	Quercus incana
American beech	Fagus grandifolia	Turkey oak	Quercus laevis
American holly	Ilex opaca	Laurel oak	Quercus laurifolia
Sweetgum	Liquidambar styraciflua	Blackjack oak	Quercus marilandica
Yellow-poplar	Liriodendron tulipifera	Myrtle oak	Quercus myrtifolia
Southern magnolia	Magnolia grandiflora	Willow oak	Quercus phellos
Sweetbay	Magnolia virginiana	Live oak	Quercus virginiana
Eastern hophornbeam	Ostrya virginiana	Cabbage palmetto	Sabal palmetto
Red bay	Persea borbonia	Winged elm	Ulmus alata
Sand pine	Pinus clausa		

Shrubs and Vines:

Common Name	Scientific Name	Common Name	Scientific Name
American beautyberry	Callicarpa americana	Runner oak	Quercus pumila
Rosemary	Ceratiola ericoides	Sand post oak	Querus stellata var. margaretta
Gopher apple	Chrysobalanus oblongifolia	Sand live oak	Quercus virginiana var. maritima
Hawthorn	Crataegus spp.		
Carolina jessamine	Gelsemium sempervirens	Shining sumac	Rhus copallina
St. Andrews cross	Hypericum hypericoides	Scrub palmetto	Sabal etonia
Large gallberry	Ilex coriacea	Bush palmetto	Sabal minor
Smooth gallberry	Ilex vomitoria	Saw palmetto	Serenoa repens
Yaupon	Ilex vomitoria	Saw greenbrier	Smilax bona-nox
Staggerbush	Lyonia ferruginea	Cat greenbrier	Smilax glauca
Fetterbush	Lyonia lucida	Common greenbrier	Smilax rotundifolia
Waxmyrtle	Myrica cerifera	Common sweetleaf	Symplocos tinctoria
Devilwood	Osmanthus americanus	Tree sparkleberry	Vaccinium arboreum
Dwarf live oak	Quercus minima	Ground blueberry	Vaccinium myrsinites

Table III-4.--Some representative woody species of southern bottomland forests

Trees:

Common Name	Scientific Name	Common Name	Scientific Name
Red maple	Acer rubrum	Wax myrtle	Myrica cerifera
River birch	Betula nigra	Black tupelo	Nyssa silvatica
American hornbeam, Ironwood	Carpinus caroliniana	Red bay	Persea borbonia
		Slash pine	Pinus elliottii
Water hickory	Carya aquatica	Spruce pine	Pinus glabra
Bitternut hickory	Carya cordiformis	Loblolly pine	Pinus taeda
Pecan	Carya illinoensis	Pond pine	Pinus serotina
Sugarberry	Celtis laevigata	Water elm	Planera aquatica
Eastern redbud	Cercis canadensis	Eastern cottonwood	Populus deltoides
Titi, Buckwheat-tree	Cliftonia monophylla	Sycamore	Platanus occidentalis
Flowering dogwood	Cornus florida	Cherrybark oak	Quercus falcata var. pagodaefolia
Titi, Swamp cyrilla	Cyrilla racemiflora		
Common persimmon	Diospyros virginiana	Laurel oak	Quercus laurifolia
American beech	Fagus grandifolia	Overcup oak	Quercus lyrata
Green ash	Fraxinus pennsylvanica	Swamp chestnut oak	Quercus michauxii
Pumpkin ash	Fraxinus profunda	Water oak	Quercus nigra
Waterlocust	Gleditsia aquatica	Nuttall oak	Quercus nuttallii
Black walnut	Juglans nigra	Willow oak	Quercus phellos
Sweetgum	Liquidamber styraciflua	Shumard oak	Quercus shumardii
Yellow-poplar	Liriodendron tulipifera	Black willow	Salix nigra
Southern magnolia	Magnolia grandiflora	Baldcypress	Taxodium distichum
Sweetbay	Magnolia virginiana	American elm	Ulmus americana
Red mulberry	Morus rubra		

Shrubs and Vines:

Common Name	Scientific Name	Common Name	Scientific Name
Red buckeye	Aesculus pavia	Smooth gallberry	Ilex glabra
Peppervine	Ampelopsis arborea	Yaupon	Ilex vomitoria
Devils walking stick	Aralia spinosa	Virginia willow	Itea virginica
Rattan vine	Berchemia scandens	Japanese honeysuckle	Lonicera japonica
Trumpet creeper	Campsis radicans		
Button bush	Cephalanthus occidentalis	Devilwood	Osmanthus americanus
		Poison ivy	Rhus radicans
Fringetree	Chionanthus virginicus	Poison sumac	Rhus vernix
Hawthorn	Crataegus spp.	American elder	Sambucus canadensis
Strawberry bush	Euonymus americanus	Laurel greenbrier	Smilax laurifolia
Swamp privet	Forestiera acuminata	Common greenbrier	Smilax rotundifolia
Carolina jessamine	Gelsemium sempervirens	Tree sparkelberry	Vaccinium arboreum
Large gallberry	Ilex coriacea	Possumhaw viburnum	Viburnum nudum
Possumhaw	Ilex decidua		

Wet meadows are areas dominated by herbaceous species that generally maintain continuous growth during most of the growing season and have seasonally wet periods that prohibit grazing. In these areas, sedges, rushes, grasses, and forbs along with occasional shrubs predominate.

In the brush vegetation cover category, shrubs and small tree species are dominant. Availability and persistence of herbaceous species are dependent upon the amount of brush cover. In dense brush vegetation, herbaceous species may be severely limited. Post oak and blackjack oak represent the more "tree-like" brush vegetation category which occurs on the LBJ National Grassland in Texas. Cedar, wild plum, and sumac represent the more "shrub-like" category of range brush-vegetation which occurs on the Caddo National Grassland in Texas.

Herbaceous range plants grow within conifer and hardwood forests. These categories occur as understory species within the previously described forest vegetation categories. The conifer cover types for the Coastal Plain/Piedmont refer to the oak-hickory-pine and southern mixed forest vegetation categories, while the hardwood cover (as used here) category for range vegetation refers to the Southern bottomland hardwood forest vegetation grouping. The more important woody browse species are discussed under the forest vegetation categories section and listed in tables III-2 through III-4.

Within oak-hickory-pine forests, common herbaceous range forage species in open areas include little bluestem (Schizachyrium scoparium), pinehill bluestem (S. scoparium var. divergens), broomsedge bluestem (Andropogon virginicus), crabgrass (Digitaris spp.), panicums (Panicum spp.), and paspalums (Paspalum spp.). Beneath denser canopies the spikegrasses (Uniola spp.) predominate. Common forbs, comprised mainly of legumes and composites, include tickclovers (Desmodium spp.), lespedeza (Lespedeza spp.), partridgepea (Cassia spp.), goldenrod (Solidago spp.), aster (Aster spp.), ragweed (Ambrosia spp.), dogfennel (Eupatorium capillifolium), yankee weed (E. compositifolium), and blackeyed susan (Rudbeckia hirta).

Within longleaf-slash pine forests, herbaceous range forage vegetation is divided into two associations (see figure III-2). In the western portion of the Gulf Coastal Plain the dominant herbaceous vegetation is bluestem grasses. Most common among the grass species are little bluestem (Schizachyrium scoparium), pinehill bluestem (S. scoparium var. divergens), slender bluestem (A. tener), broomsedge bluestem (A. virginicus), pineywoods dropseed (Sporobolus junceus), panicums (Panicum spp.), and paspalums (Paspalum spp.).

In the eastern Gulf Coastal Plain (Florida, south Georgia, and southeast Alabama) species of wiregrass are the dominant herbaceous vegetation associated with longleaf-slash pine forests. Pineland threeawn (*Aristida stricta*), bottlebrush threeawn (*A. spiciformis*), and arrowfeather threeawn (*A. purpurascens*) are the most prevalent wiregrasses. Other common grasses include creeping bluestem (*Schizachyrium stoloniferum*), chalky bluestem (*Andropogon capillipes*), broomsedge bluestem (*A. virginicus*), curtis dropseed (*Sporobolus curtissii*), lopside indiangrass (*Sorghastrum secundum*), panicums (*Panicum* spp.), and paspalums (*Paspalum* spp).

Forbs common to both associations include tickclover (*Desmodium* spp.), lespedeza (*Lespedesa* spp.), partridge pea (*Cassia* spp.), tephrosia (*Tephrosia* spp.), rhynchosia (*Rhynchosia* spp.), asters (*Aster* spp.), eupatoriums (*Eupatorium* spp.), goldenrod (*Solidago* spp.), deer tongue (*Trilisia odoratissima*), grassleaf goldaster (*Herterotheca graminifolia*), and swamp sunflower (*Helianthus angustifolius*). Other plant species, such as the bracken fern (*Pteridium aquilinium*), cinnamon fern (*Osmunda cinnamomea*), and prickly pear cactus (*Opuntia humifusa*) are also prominent in these forests.

Use of range forage is highest within Texas, Louisiana, Mississippi, and Florida. Except for the national grasslands in Texas, most of the range resources are associated with regeneration areas and openings within longleaf-slash and loblolly-shortleaf pine forests.

In 1986 on national forest land in the Coastal Plain/Piedmont 17,861 cattle and 23 horses used approximately 142,000 animal unit months of forage on 381 range allotments totalling 1.2 million acres.

c. Wilderness

There are 171,539 acres of wilderness in the Coastal Plain/Piedmont. Wilderness areas vary in size from 940 to 24,600 acres. The wilderness system ranges from bays, swamps, and hardwood river bottoms to rolling pine uplands, and includes a wide variety of plants and animals. Exclusion of fire has increased the risk of wildfire and has complicated fire control.

Vegetation management is not generally practiced in wilderness areas, but natural or prescribed fire may be necessary to ensure protection of rare and endangered species, and reduce unnatural fuel buildups. Other forms of vegetation management are minor.

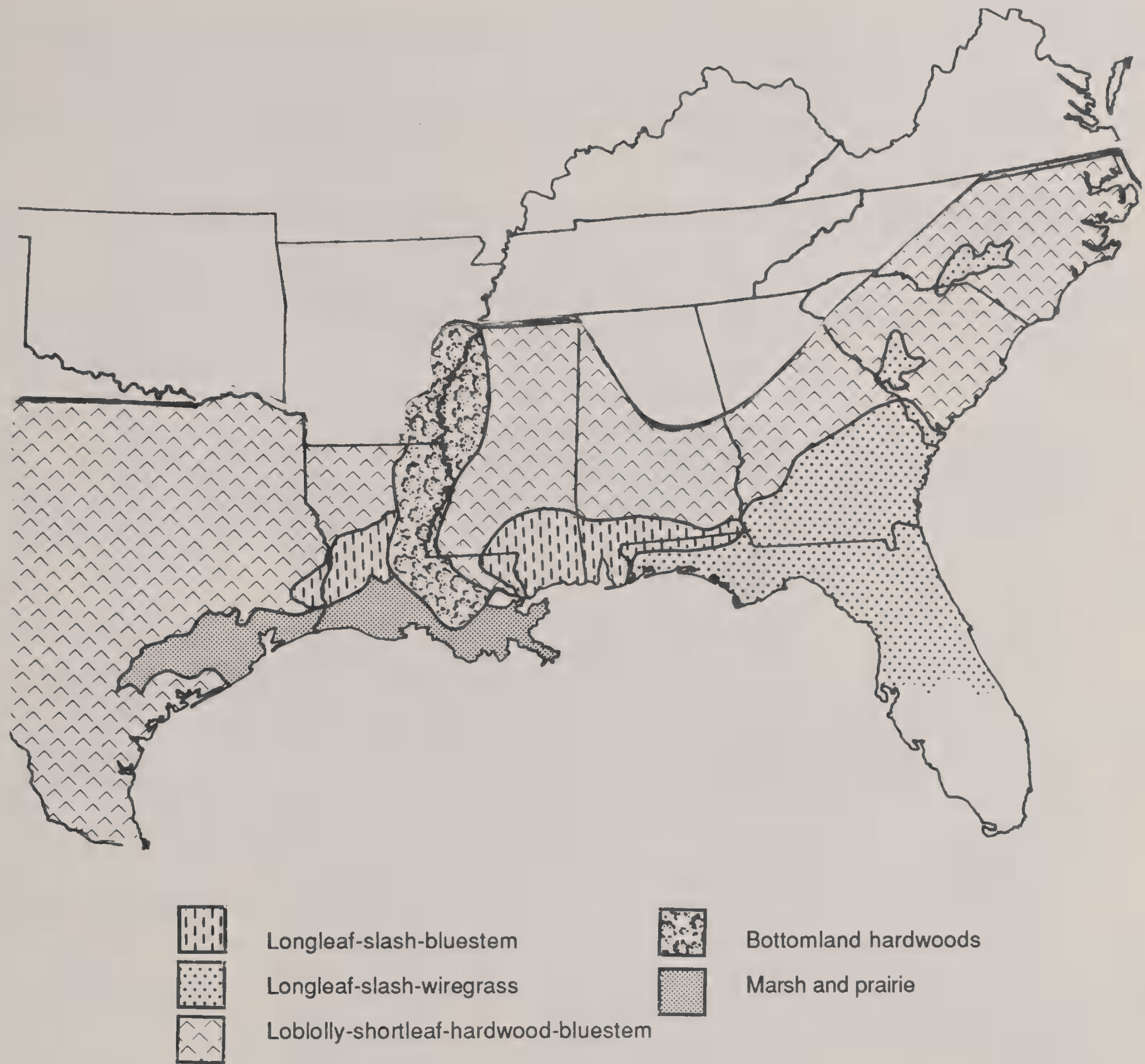


Figure III-2.--Forest range types of the Coastal Plain/Piedmont.

d. Fire Management

Periodic fires, both natural and man-caused, have historically influenced formation of Coastal Plain/Piedmont ecosystems (Komarek 1968; Kozlowski and Ahlgren 1974; Wade 1983). Coastal Plain pine forests are recognized as fire-dependent subclimax formations (Braun 1950; Oosting 1956). Many plants in these forests, such as wiregrass, pitcher plants, longleaf, pond and sand pine, specifically depend upon fire during parts of their life cycles.

Fire exclusion from the late 1920's until the late 1940's adversely affected fire-dependent ecosystems where fire had previously maintained them. Today fire management is used to reduce damage from wildfire and maintain fire-dependent ecosystems, as well as for other purposes.

Average annual acres treated by prescribed fire:

1. Fuel Reduction	180,000
2. Wildlife Habitat (including T&E)	81,000
3. Range Management	34,000
4. Site Preparation	15,000
5. Timber Stand Improvement	32,000

2. Wildlife and Aquatic Animals

Southern forest and grassland ecosystems support a great variety of terrestrial and aquatic animal life. This variety reflects the wide range of climatic conditions, forest and range types, and successional stages on national forests and grasslands.

Big-game species include white-tailed deer (Odocoileus virginianus), eastern wild turkey (Meleagris gallopavo), and black bear (Ursus americanus). Important small-game species are bobwhite quail (Colinus virginianus), eastern mourning dove (Zenaida macroura), cottontail rabbit (Sylvilagus floridanus), gray (Sciurus carolinensis) and fox squirrel (Sciurus niger), ruffed grouse (Bonasa umbellus), several species of waterfowl, and American woodcock (Philohela minor). Major fur-bearing species include raccoon (Procyon lotor), mink (Mustela vison), muskrat (Ondatra zibethicus), gray fox (Urocyon cinereoargenteus), red fox (Vulpes fulva), bobcat (Lynx rufus), and eastern coyote (Canis latrans). Game fish include cool-water species such as smallmouth bass (Micropterus dolomieui), warm-water species such as largemouth bass (Micropterus salmoides), and anadromous species such as striped bass (Morone saxatilis). Thousands of other species of birds, mammals, reptiles, amphibians, fish, and invertebrates also live in or near our forests.

The Forest Service routinely manages habitat for game and nongame wildlife and fish. State wildlife resource agencies are responsible for establishing wildlife management regulations and enforcement. These efforts are integrated and coordinated through cooperative programs of the Forest Service and other agencies.

3. Proposed, Threatened, Endangered and Sensitive Species

Sixteen animal species classified by the U.S. Fish and Wildlife Service as threatened or endangered (or proposed for listing as threatened or endangered) live in Coastal Plain/Piedmont national forests or grasslands. The list includes three species of mammals, six species of birds,

five species of reptiles, one fish species, and one species of mollusk (table III-5). Four plant species with Federally threatened or endangered status (table III-6) occur. Habitats of these species are managed under authority of the Endangered Species Act with the goal of population recovery.

In addition, the Forest Service has classified a number of animal and plant species on Coastal Plain/Piedmont forests as "sensitive" (tables III-7 and III-8). Habitats of sensitive species are managed to ensure population levels which will keep these plants and animals from becoming threatened or endangered.

Forest Land and Resource Management Plan standards and guides protect streamside zones and wetlands. These measures prevent risk to such species as the West Indian Manatee, American alligator, Flattened musk turtle, Shortnose sturgeon, and Mississippi pearl mussel.

Also, some sensitive species are unaffected by vegetation management actvities (table III-7). The golden eagle, for example, is a winter visitor only. All other species identified with a "NO" in the table are adequately protected by Plan standards and guides which provide for streamside protection zones and protect wetlands, or in the case of sensitive plants, occur only where no vegetation management takes place.

Table III-5.--Listed by Federal government as endangered, threatened, or proposed animal species on Coastal Plain/Piedmont national forests

Common Name	Scientific Name	Status	States Classified T,E,&P	Veg Mgmt Without Mitigation May Affect
Bat, gray	*Myotis grisescens*	E	AL,FL	YES
Bat, Indiana	*Myotis sodalis*	E	AL,FL	YES
Manatee, West Indian	*Trichechus manatus*	E	FL	NO
Crane, Mississippi sandhill	*Grus canadensis*	E	MS	YES
Eagle, bald	*Haliaeetus leucocephalus*	E	AL,FL,GA,LA,MS, NC,SC,TX	YES
Falcon, peregrine	*Falco peregrinus*	E	AL,GA,NC,SC	YES
Jay, Florida scrub	*Aphelocoma coerulescens*	T	FL	YES
Stork, wood	*Mycteria americana*	E	FL,GA,SC	YES
Woodpecker, red-cockaded	*Picoides borealis*	E	AL,FL,GA,LA,MS, SC,TX	YES
Alligator, American	*Alligator mississippiensis*	T	AL,FL,GA,LA,MS, NC,SC	NO
Skink, sand	*Neoseps reynoldsi*	T	FL	YES
Snake, Eastern indigo	*Drymarchon corais*	T	AL,FL,GA,MS,SC	YES
Tortoise, gopher	*Gopherus polyphemus*	T	MS	YES
Turtle, flattened musk	*Sternotherus depressus*	T	AL	NO
Sturgeon, shortnose	*Acipenser brevirostrum*	E	FL,GA,NC,SC	YES
Mussel, Louisiana pearl	*Margeritifera hembli*	E	LA	YES

Table III-6.--Listed by Federal government as threatened, endangered, and proposed plant species on Coastal Plain/Piedmont national forests

Common Name	Scientific Name	Status	States Classified T,E,&P	Veg Mgmt Without Mitigation May Affect
Large-flowered bonamia	*Bonamia grandiflora*	T	FL	YES
Swamp spice bush; Jove's-fruit	*Lindera melissaefolium*	E	GA,MS,NC,SC	YES
Yellow-petaled harper's beauty	*Harperocalis flava*	E	FL	YES
Florida gooseberry	*Ribes echinellum*	T	FL,SC	YES

A "YES" in the right hand columns on tables III-5, 6, 7, and 8 indicates that, for that species, without mitigation measures, adverse impacts from vegetation management may occur. Possible adverse effects are discussed in chapter IV. Measures to mitigate or prevent these effects are presented in chapter II.

Table III-7.--Forest Service list of sensitive animal species on Coastal Plain/Piedmont national forests

Common Name	Scientific Name	States Classified Sensitive	Veg Mgmt Without Mitigation May Affect
Bear, black	Ursus americanus	MS,SC	YES
Bear, Florida black	Ursus americanus floridanus	FL	YES
Mole, star-nosed	Condylura cristata	GA	YES
Mouse, Florida	Peromyscus floridanus	FL	YES
Mouse, old-field	Peromyscus polionotus	MS	YES
Shrew, masked	Sorex cinereus	GA	YES
Shrew, southern	Blarina carolinensis	GA	YES
Shrew, southern pygmy	Microsorex hoyi	GA	YES
Squirrel, fox	Sciurus niger	GA,FL	YES
Vole, red-backed	Clethrionomys gapperi	GA	YES
Crane, Florida sandhill	Grus canadensis pratensis	FL	YES
Eagle, golden	Aquila chrysaetos	GA,MS	NO
Hawk, Cooper's	Accipiter cooperii	TX	YES
Hawk, sharp-shinned	Accipiter striatus	TX	YES
Heron, little blue	Egretta caerulea	FL	NO
Heron, Louisiana	Egretta tricolor	FL	NO
Kestrel, southeastern American	Falco sparverius	FL	YES
Kite, American swallow-tailed	Elanoides forficatus	SC	YES
Limpkin	Aramus guarauna	FL	NO
Osprey, American	Pandion haliaetus	GA,MS,SC	YES
Owl, Florida burrowing	Athene cunicularia	FL	YES
Pelican, eastern brown	Pelecanus occidentalis	FL	NO
Sparrow, Bachman's	Aimophila aestivalis	MS	YES
Wren, Bewick's	Thryomanes bewickii	MS	YES
Frog, Carolina gopher	Rana areolata capito	FL	NO
Frog, dusky gopher	Rana areolata sevosa	AL	NO
Frog, green	Rana clamitans	MS	NO
Salamander, flatwoods	Ambystoma cingulatum	AL	NO
Salamander, seepage	Desmognathus aeneus	AL	NO
Salamander, Webster's	Plethodon websteri	SC	NO
Salamander, zigzag	Plethodon dorsalis	MS	NO
Skink, sand	Neoseps reynoldsi	FL	YES
Snake, black pine	Pituophis melanoleucus	MS	YES
Snake, eastern coral	Micrurus fulvius	MS	YES
Snake, Florida pine	Pituophis melanoleucus	AL,FL	YES
Snake, gulf salt marsh	Nerodia fasciata	MS	NO
Snake, Louisiana pine	Pituophis melanoleucus	LA	YES
Snake, mole	Lampropeltis calligaster	MS	YES
Snake, northern pine	Pituophis melanoleucus	GA,TX	YES
Snake, pinewoods	Rhadinaea flavilata	MS	YES
Snake, rainbow	Farancia erytrogramma	MS	YES
Snake, scarlet king	Cemophora coccinea	MS	YES
Snake, short-tailed	Stilosoma extenuatum	FL	YES
Snake, southern hog-nose	Heterodon simus	MS	YES

Table III-7.--Forest Service list of sensitive animal species on Coastal Plain/Piedmont national forests, continued

Common Name	Scientific Name	States Classified Sensitive	Veg Mgmt Without Mitigation May Affect
Tortoise, gopher	Gopherus polyphemus	AL,FL	YES
Rattlesnake, eastern diamondback	Crotalus adamanteus	AL	YES
Terrapin, diamond back	Malaclemys terrapin	MS	YES
Treefrog, pine barrens	Hyla andersoni	AL	YES
Turtle, bog	Clemmys muhlenbergi	GA	NO
Turtle, Barbour's map	Graptemys barbouri	FL	NO
Turtle, chicken	Deirochelys reticularia	MS,SC	NO
Turtle, yellow-blotched sawback	Graptemys flavimaculata	MS	NO
Bass, Suwannee	Micropterus notius	FL	YES
Chub, flame	Hemitrema flammea	AL	YES
Darter, crystal	Ammocrypta asprella	AL	YES
Darter, freckled	Percina lenticula	AL	YES
Shiner, bluenose	Notropis welaka	MS,SC	YES
Pupfish, Lake Eustis	Cyprinodon variegatus hubbsi	FL	YES
Shiner, Sabine	Notropis sabinae	TX	YES
Sturgeon, gulf	Acipenser oxyrhynchus desotoi	FL	YES
Crayfish, hillside bog	Procambarus sp.	LA	YES
Crayfish, big South Fork	Cambarus bouchardi	LA	YES
Crayfish, javelin	Procambarus jaculus	MS	YES
Crayfish, lavender burrowing	Fallicambarus byersi	MS	YES
Crayfish, Mobile	Procambarus lecontei	MS	YES
Crayfish, pearl blackwater	Procambarus penni	MS	YES
Crayfish, Jackson prairie	Procambarus barbiger	MS	YES
Crayfish, speckled burrowing	Fallicambarus danielae	MS	YES
Crayfish, spiny-tailed	Procambarus fitzpatricki	MS	YES

Table III-8.--Forest Service list of sensitive plant species on Coastal Plain/Piedmont national forests

Common Name	Scientific Name	States Classified Sensitive	Veg Mgmt Without Mitigation May Affect
Incised groovebur, cocklebur, agrimony	Agrimonia incisa	SC,MS	YES
Schwerin's indigobush	Amorpha schwerini	SC	YES
Bluestar	Amsonia glaberrima	TX	YES
Louisiana bluestar	Amsonia ludoviciana	LA	YES
Godfrey's sandwort	Arenaria godfreyi	NC	YES
Needle-grass, southern-three-awned grass, wiregrass	Aristida simpliciflora	MS	YES YES
Cutis milkweed	Asclepias curtissii	FL	YES
Savanna-milkweed	Asclepias pedicellata	SC	YES

Table III-8.--Forest Service list of sensitive plant species on Coastal Plain/Piedmont national forests, continued

Common Name	Scientific Name	States Classified Sensitive	Veg Mgmt Without Mitigation May Affect
Southern milkweed	*Asclepias viridula*	FL	YES
Carolina spleenwort	*Asplenium heteroresiliens*	NC,SC	YES
Thristle-leaved aster	*Aster eryngiifolius*	AL	YES
Pine-woods aster	*Aster spinuloses*	FL	YES
Coastal-plain-wild-indigo	*Baptisia simplicifolia*	FL	YES
Texas screw stem	*Bartonia texana*	TX	YES
Ashe's savory	*Calamintha ashei*	FL	YES
Biltmore sedge	*Carex biltmoreana*	GA	YES
Chapman's sedge	*Carex chapmanii*	SC	YES
Hairy lip fern	*Cheilanthes lanosa*	LA	NO
Rosebud orchid	*Cliestes divaricata*	AL,MS	YES
Yellow lady's slipper	*Cypripedium calceolus*	GA	YES
Yellow lady's slipper	*Cypripedium calceolus* var. *pubescens*	AL,MS	YES
Tennessee bladder fern	*Cystopteris tennesseensis*	NC	YES
Shooting star	*Dodecatheon meadia*	LA	YES
Texas pipewort	*Eriocaulon texense*	MS	YES
Long-leaved wild buckwheat	*Eriogonum longifolium*	LA	YES
Many-flowered wild buckwheat	*Eriogonum multiflorum*	LA	YES
Eulophia, false-coco	*Eulophia ecristata*	LA,MS	YES
Wahoo, eastern strawberry-bush	*Euonymus atropurpureus*	AL	YES
Glade spurge	*Euphorbia purpurea*	SC,AL	YES
Loblolly bay, jan bay, red bay,	*Gordonia lasianthus*	MS	YES
Mock penny royal	*Hedeoma graveolens*	FL	YES
Purple bluet	*Hedyotis purpurea calycosa*	LA	YES
Slender heliotrope	*Heliotropium tenellum*	LA	YES
Crested coral root	*Hexalectris spicata*	MS	YES
Neches river tose-mallow	*Hibiscus dasycalyx*	TX	YES
Golden seal	*Hydrastis canadensis*	AL	YES
Juneberry holly, sarvis holly	*Ilex amelanchier*	MS	YES
Star-anis, yellow anis tree	*Illicium parviflorum*	FL	NO
Butternut	*Juglans cinerea*	MS	YES
Thick-leaved water willow	*Justicia crassifolia*	FL	YES
Bog button	*Lachnocaulon digynum*	MS	YES
Slender gay-feather	*Liatris temios*	TX	YES
Panhandle lily	*Lillium iridollae*	AL	YES
Bog spicebush	*Lindera subcoriacea*	MS	YES
Nodding clubmoss	*Lycopodium cernuum*	LA	YES
White bird-in-a-nest	*Macbridea alba*	FL	YES
Ashe's magnolia	*Magnolia ashei*	FL	NO
Bog moss	*Mayaca aubleti*	LA	YES
Loose watermilfoil	*Myriophyllum laxum*	SC,AL,NC	NO
Florida beargrass	*Nolina atocarpa*	FL	YES
Big floating heart	*Nymphoides aquatica*	MS	YES
Ginseng	*Panax quinquefolia*	GA,SC,AL,MS	YES
Naked-stemmed panicum	*Panicum nudicaule*	MS	YES

Table III-8.--Forest Service list of sensitive plant species on Coastal Plain/Piedmont national forests, continued

Common Name	Scientific Name	States Classified Sensitive	Veg Mgmt Without Mitigation May Affect
Carolina-grass-of-parnassus	Parnassia caroliniana	FL	YES
Large-flowered grass of parnassus	Parnassia grandifolia	FL,SC	YES
White arum	Peltandra sagittaefolia	AL	NO
Beard-tongue	Penstemon tenuis	MS	YES
Pine barrens prairie-clover	Petalostemon gracilis	MS	YES
Climbing fetterbush	Pieris phillyreifolia	SC,AL	NO
Violet-flowered butterwort	Pinguicula ionantha	FL	YES
Chapman's butterwort	Pinguicula planifolia	MS	YES
Butterwort	Pinguicula primuliflora	AL	NO
Bent golden aster	Pityopsis flexuosa	FL	YES
Yellow fringeless orchid	Platanthera integra	SC,LA,MS	YES
Clammy weed	Polansia erosa	LA	YES
Creeping polemonium	Polemonium reptans	MS	YES
Small lewton's mulkwort	Polygala lewtonii	FL	YES
Arkansas oak	Quercus arkansana	AL	YES
Dwarf post oak	Quercus boyntonii	TX	YES
Oglethorpe oak	Quercus oglethorpensis	GA,SC	YES
Spine palm, common needle palm	Rhapidophyllum hystrix	AL,MS	YES
Small-flowered meadow beauty	Rhexia parviflora	FL	YES
Panhandle meadow beauty	Rhexia salicifolia	AL	YES
Florida azalea	Rhododendron austrinum	AL	YES
Large beaked-rush	Rhychospora macra	MS	YES
Palmetto	Sable minor	GA	YES
Florida willow	Salix floridana	FL	NO
Parrot pitcher plant	Sarracenia psittacina	AL	YES
Wherry's pitcher plant	Sarracenia rubra	AL	YES
Chaffseed	Schwalbea americana	SC	YES
Spikemoss	Selaginella riddellii	LA	YES
False Soloman's-Seal	Smilacina racemosa	LA	YES
Eared goldenrod	Solidago auriculata	LA	NO
Spring-flowering goldenrod	Solidago verna	NC	YES
Giant spiral orchid	Spiranthes longilabris	MS	YES
Silky camellia	Stewartia malacodendron	AL	NO
American columbo	Swertia carolinensis	SC,MS	YES
Pineland hoary pea	Tephrosia mohrii	AL	YES
Bristle fern	Trichomanes boschianum	SC	YES
Trillium, foetid trillium	Trillium foetidissimum	MS	YES
Three bird's orchid	Triphora trianthophora	LA	YES
Dwarf bladderwort	Utricularia olivacea	NC	YES
Purple bladderwort	Utricularia purpurea	AL	NO
Chapman's crownbeard	Verbesina chapmanii	FL	YES
Crownbeard	Verbesina heterophylla	FL	YES
Ocala vetch	Vicia ocalensis	FL	NO
Drummond's yellow-eyed grass	Xyris drummondii	LA	YES
Kral's yellow-eyed grass	Xyris longisepala	LA	YES
Harper's yellow-eyed grass	Xyris scabrifolia	MS	YES

4. Soils

Soils of the Coastal Plain/Piedmont differ in geology, climate, topography, and land-use history. Although soil types vary greatly, the following six soil orders are most common:

(1) Ultisols are well-developed acid soils with strong clay accumulation in subsoil and intense leaching of bases. These soils are moderately productive and dominate the Piedmont and Middle Coastal Plain. Seasonally saturated ultisols dominate the Atlantic flatwoods and are associated with organic soils in swamps and pocosins.

(2) Alfisols are well-developed soils with clay accumulation in subsoil and slight leaching of bases. These soils are highly productive and dominate the loess uplands along the Mississippi Valley and clay prairies in Texas.

(3) Vertisols are mixed clays that crack when dry. These soils are highly productive and dominate the clay lowlands of Mississippi.

(4) Entisols are undeveloped soils low in organic matter or clay accumulation. These soils are rather unproductive and occur largely as acid, permeable sands in the Lower Coastal Plain. Entisols in river valleys, however, result from flood deposition and are quite productive due to nutrient and moisture enrichment.

(5) Inceptisols are poorly developed, often shallow acid soils with thin topsoil and little clay accumulation in subsoil. These soils are rather unproductive and occur mostly in the Lower Coastal Plain. Inceptisols in river valleys, however, result from flood deposition and are highly productive due to nutrient and moisture enrichment.

(6) Spodosols are intensely leached sands with mixtures of organic matter, iron, and aluminum in subsoil. These soils are rather unproductive and occur largely in the Florida flatwoods.

Productivity of entisols, inceptisols, and spodosols is limited by nitrogen deficiency. Ultisols in the Piedmont and Upper Coastal Plain and alfisols in the loess uplands that were severely eroded by past farming are extremely deficient in nitrogen and organic matter. Productivity of seasonally saturated soils in the flatwoods is also limited by phosphorus deficiency. Most nutrients are chemically bound in the topsoil.

During the wet season loam and clay soils in flatwoods and river valleys are especially subject to compaction from mechanical equipment. When wet, vertisols are also subject to equipment damage because they tend to shrink and swell.

5. Water

The humid subtropical climate of the Coastal Plain/Piedmont produces abundant water. Annual runoff is 10-20 inches per year in most areas but exceeds 30 inches along the Gulf Coast. Streamflows are usually highest in winter and early spring and lowest in late summer and fall.

The Coastal Plain is underlain by aquifers of sand, sandstone, and limestone that produce ample ground water. Valley deposits of rivers flowing to the Gulf are productive aquifers. The metamorphic and igneous rocks of the Piedmont yield little water, so most use comes from surface sources.

In the Lower Coastal Plain, sandy soils, flat slopes, and level streams limit erosion and sediment yield. Streams are wide and shallow and strongly influenced by water tables. Floodplains are broad, and watershed divides are hard to distinguish.

In the Middle and Upper Coastal Plain, stream and floodplain dimensions vary with geology and size of stream. Channel erosion is often the most important source of sediment, but potential surface erosion is especially high in the loess uplands along the Mississippi Valley.

In the Piedmont, streams and floodplains tend to be narrow. Intense rains can produce significant sediment from gullies. Potential surface erosion is high, but much sediment is caused by channels naturally cutting through valley deposits from past farmland erosion.

National forest lands contain more than 3,600 miles of perennial streams and 110,000 acres of lakes and ponds. Nearly 70 percent of the lake area occurs in the Florida sand ridges. Surface water generally exceeds water quality standards except where degraded by upstream land uses.

Wetlands are abundant in the Lower Coastal Plain but are confined to floodplains and upland depressions elsewhere. More than 90 percent of the 600,000 acres of wetlands occurs in the Lower Coastal Plain. Executive Orders 11988 (Floodplain Management) and 11990 (Protection of Wetlands) protect the flood-moderating value of floodplains and the ability of wetlands to produce abundant and diverse plants and animals, regulate water flow and quality, and recharge ground water.

6. Air

In the dormant season, air flow and quality are influenced by migrating, frequently changing air masses and storm systems. In the growing season, air flow and quality are strongly influenced by the Atlantic permanent high-pressure system. The system's clockwise spiral movement pumps tropical air into the region from the Gulf of Mexico. Prevailing winds in all seasons are from the southwest.

Air quality is generally good throughout the region in winter and spring, because unstable weather patterns tend to keep the atmosphere well mixed. Occasional periods of stagnation occur in summer and fall when natural and manmade pollutants may concentrate. While no major industrial centers are located in this region, pollutants emanate from local sources including cities. Pollutants may also be transported into the region from long distances.

Geographic areas are classified as either Class I, II, or III. Class I areas have the best air quality and are mandated for special protection. Class II and III areas have air qualities that exceed National Ambient Air Quality Standards established by the United States Environmental Protection Agency. Protection of Class II and III areas is not as stringent as for Class I areas. All of the Coastal Plain/Piedmont is Class I or II. Five Class I areas are potentially affected (table III-9).

Table III-9.--Class I areas and jurisdictions

Class I Area	State	Responsible Agency
Bradwell Bay Wilderness	Florida	USDA Forest Service
St. Marks NWR	Florida	USDI Fish and Wildlife Service
Okefenokee NWR	Georgia	USDI Fish and Wildlife Service
Cape Romain NWR	South Carolina	USDI Fish and Wildlife Service
Swanquarter NWR	North Carolina	USDI Fish and Wildlife Service

NWR = National Wildlife Refuge

Only Bradwell Bay Wilderness is managed by the Forest Service. The other four Class I areas, however, are located within 60 miles of national forests and could be affected by management actions. Other potentially affected areas include populated areas and highways downwind from national forests.

7. Rights-of-Way Corridors

Rights-of-way include roads, trails, utility corridors, and railroads. Historically, vegetation control programs for rights-of-way maintenance have included the full range of options including manual, mechanical, biological, fire, and herbicides.

a. Roads

Roadside vegetation is controlled to protect investment and to provide user safety in concert with the road's intended use. Forest Service roads in the Coastal Plain/Piedmont total 12,800 miles. Using mostly mechanical methods, crews maintain about 13,000 acres of vegetation along roads to one of five levels. Amount of traffic and maintenance requirements increase with each level:

Maintenance Level	Miles
1	1,247
2	6,986
3	3,558
4	928
5	81
Total	12,800

Roads and highways maintained by other Federal, State, and county agencies total 2,077 miles, requiring 23,000 acres of maintenance. Vegetation management is performed on road shoulders to enhance drainage; on cut and fill slopes to provide increased sight distance; and along roadsides to control danger trees.

b. Trails

Trails provide outdoor recreation opportunities and access to scenic and cultural resources. Trailside vegetation is controlled to provide for user safety, protect the investment, and enhance trailside appearance. Manual and mechanical methods are chiefly used.

Hiking, off-road vehicle, horse, and canoe trails make up the 1,452 miles of trail that require vegetation management: Hiking, 733 miles; horseback, 294 miles; off-road vehicle, 158 miles; and canoe, 267 miles.

c. Utility Corridors

Many powerline and communication utilities have above-ground and buried cable lines through national forests. Vegetation management is performed along these areas to enhance transmission system reliability, provide public and worker safety, and access facilities. Some rights-of-way are maintained annually and others intermittently at up to 10-year intervals.

There are 3,325 miles of utility corridors of varying width that include 9,698 acres of national forest lands. About 1,600 acres are maintained each year. Vegetation control programs are used to keep trees from growing across conductors, thus preventing power outages and possible forest fires. Vegetation is also controlled along access roads. Manual, mechanical, and herbicide methods are used.

d. Railroads

Railroad transportation systems have rights-of-way, access roads, crossings, and communication facilities that require annual vegetation control on national forest lands. All methods may be used. Only 5 miles of railroad right-of-way exist on national forests.

e. Pipelines

Vegetation controls are used annually on about 4500 acres along 1000 miles of oil and gas pipelines. These controls allow for detection of leaks, control of undesirable plants, public and worker safety, and access.

8. Visual Quality

Landscapes vary from thick swamps to open grasslands. Prominent features of these landscapes include rock forms and landforms, water forms, and vegetative patterns.

Inventoried visual quality levels are determined by "distance zone,", the distance at which a landscape is viewed; "sensitivity level," the number and interest level of people viewing the scene; and "variety class," the interest and visual diversity a landscape affords.

A Visual Quality Objective (VQO)is assigned to each landscape which describes the degree of alteration permissible for each management situation. This VQO does not always match the inventoried condition. VQO's constitute a ranking which can be described as follows:

Increasing protection & enhancement of the natural landscape required	1. Preservation VQO 2. Retention VQO 3. Partial Retention VQO 4. Modification VQO 5. Maximum Modification VQO	Increasing alteration of the natural landscape permitted

9. Cultural Resources

Cultural resources are artifacts, buildings, or sites resulting from past human activity. They can be archaeological, historical, prehistoric, or architectural. Cultural resources are irreplaceable and of great concern to the public. Examples are remnants of old wagon roads, homesteads, Civilian Conservation Corps structures, or native American camp sites or mound complexes.

Laws and regulations require that Federal agencies manage the cultural resources under their control. Procedures are followed to assure that cultural values are considered in any decision-making process. These procedures include inventorying, evaluating, determining effects, and mitigating adverse effects.

In the Coastal Plain/Piedmont, 15 percent of the area has been inventoried at varied intensities for cultural resources. Approximately 2000 historic and 4000 prehistoric sites have been recorded through FY 1986.

10. Fuels

The climate and physiography of the Coastal Plain/Piedmont support nine major fuel types with differing burning characteristics. In any fuel type, fire intensity can vary greatly depending on topography, weather (rainfall, humidity, wind), and the amount, size distribution, degree of concentration, moisture content, and chemistry of available fuels. In general, more fuels become available

during periods of low live fuel moisture, such as fall and winter when vegetation is dormant or during spring and summer droughts. The major fuel types are:

a. Hardwoods found mostly in bottomlands and wetlands. Available fuels can include leaves, forbs, decaying woody material, humus, and evergreen hardwoods such as American holly. Fuel loads are generally low and support low intensity surface fires.

b. Pine-hardwood distributed throughout the region. Overstory is pine or mixed pine-hardwood with hardwood understory. Available fuels can include needle and leaf litter, grasses, forbs, decaying woody material, and evergreen hardwoods. Fuel loads are generally high in unmanaged stands and support moderate-intensity surface fires.

c. Pine-grasses located mostly in middle and lower Coastal Plain. Overstory is made up of open pines that have been managed with periodic prescribed fires. Available fuels can include grasses, forbs, needle litter, and scattered hardwood brush. Surface fires move rapidly and are generally of moderate intensity.

d. Pine-palmetto/gallberry found in lower Coastal Plain forests. Pines dominate the overstory. Available fuels can include grasses, forbs, needle litter, dense palmetto or gallberry, and other brush. Fuel loads and flammability can be high, often supporting intense surface fires burning into crowns.

e. Grass or plantations (before crown closure) distributed throughout the region and includes national grasslands in Texas. Available fuels can include grasses, forbs, and hardwood brush. Surface fires move rapidly and often involve pine foliage.

f. Pine plantations (after crown closure) established throughout the region. Available fuels can include needle litter and scattered hardwood brush. Fuel loads are moderate and normally support slow to moderate moving surface fires with low to moderate intensity, depending on type and amount of brush present.

g. Sand pine (a fire-dependent species) forming dense stands in Florida sand ridges. Available fuels are light needle litter and scattered forb-brush understory that produce low-intensity creeping fires. Sand pine needles contain combustible substances that can become flammable in dry weather and promote intense crown fires.

h. Pond pine (a fire-dependent species) found in North Carolina pocosins with dense evergreen and decidious shrub understory. Available fuels are dense brush, live and dead needles, and humus. During droughts organic soils become available, causing intense fires that are hard to put out.

i. Logging slash associated with harvest cuts and heavy thinnings. Available fuels can include all cut down living and dead plant materials. Fires can be very intense if slash is heavy, concentrated, and dry.

11. Socioeconomics

Within the boundaries of national forests in the Coastal Plain/Piedmont are 4 million acres of private land. Private landowners are mostly large industrial timber companies, residents, small businesses, and absentee landowners who use their land for recreation, farming, hunting, and woodlots.

The South's population has outpaced the nation's population growth rate since 1970, and this trend is expected to continue through 1990. Net migration from the northeast and midwest sections of the country contributed substantially to the 1975-84 growth trends (Bureau of Census, Series P-20, No. 407). The South was the only U.S. census region to experience a net immigration from all other regions of the country according to a recent report (Geographic Mobility 1983-84, Bureau of Census, Series P-20, No. 407). The trend towards non-metropolitan areas which emerged in the 1970's appears to be reversing with non-metropolitan areas losing population in 1983-84 study. Movement from the central city to the suburbs continues. Growth is projected to continue into the future, and the coastal States are expected to grow fastest, with Florida leading (table III-10).

Table III-10.--Population and population projections

State	Population (thousands)		Population Projections (thousands)	
	1977	1986	1990	2000
Alabama	3,691	4,052	4,214	4,415
Florida	8,466	11,676	13,316	17,438
Georgia	5,041	6,104	6,175	6,708
Louisiana	3,930	4,501	4,747	5,160
Mississippi	2,386	2,625	2,761	2,939
North Carolina	5,515	6,333	6,473	6,868
South Carolina	2,878	3,377	3,560	3,907
Texas	12,806	16,685	17,498	20,739
Total	44,713	55,352	58,744	68,174

Total employment in the Region has followed population trends, with 48 percent of the population being employed in 1986 (48

percent participation ratio is slightly below the U.S. ratio of 50 percent). Employment by major sector follows national trends. The Region, however, shows slightly greater dependence on government employment. Also, the small amount of durable-goods manufacturing has allowed the South to be less influenced by recessionary pressures than the rest of the nation. The Region since the 1940's has escaped severe inventory corrections that cause unemployment (Haulk 1980). As a result, unemployment rates generally have been below national averages during periods of recession. Figure III-3 displays employment by major industry in the Southern Region, and table III-11 shows employment by major industries by State, 1983.

Agriculture and related services have declined in relative importance and account for less than 10 percent of total employment in the region. The decline has been more than offset by growth in the services sector. However, most rural counties, although they make up a small part of the total population, are still very dependent on agriculture and related services for employment.

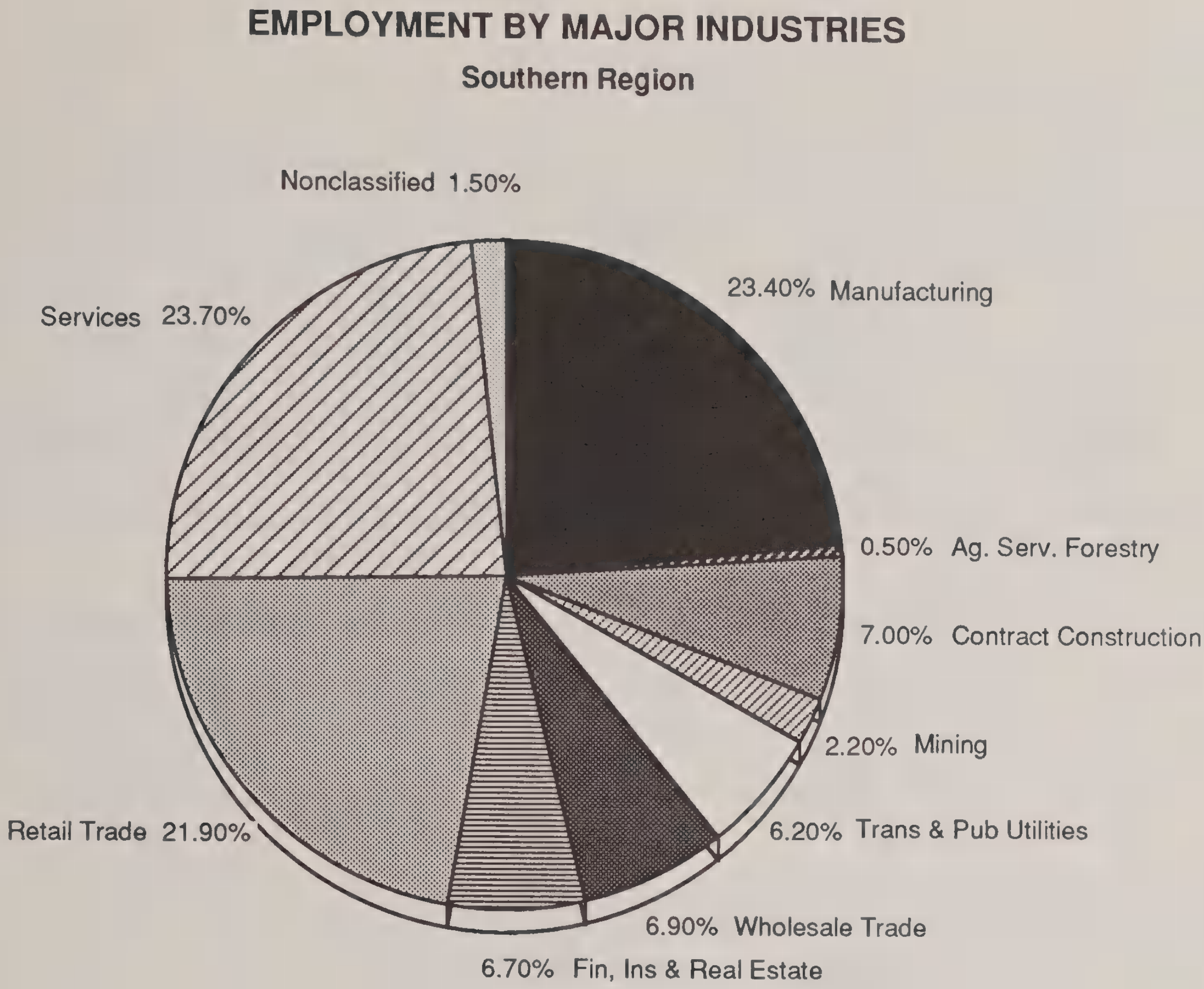
Per capita income for the South historically has been below the national average. In 1983, it averaged $8,381, which is 12 percent below the national average. Wages and salaries earned in agricultural and light industrial occupations, predominant in the South, are lower than those earned in heavy manufacturing. Projections of per capita income reflect substantial increases at national and regional levels, with proportional gains in the South.

The South has traditionally depended on forest and range resources for goods and services. Current projections indicate that these resources will become more important in the future. Land managers recognize that effects of their actions extend far beyond national forests, and that they must be familiar with relationships between natural resource management and the social and cultural environment.

Forest users have diverse motives and expectations. Some value the very existence of forests and need not visit them to derive satisfaction. At the other end of the spectrum are people who value forests for products which contribute greatly to our high living standards.

People's expectations of the forest are fulfilled through experiences. These experiences can be recreational, occupational, or just casually related to the daily living environment. Forest experiences occur in one of five kinds of areas or settings which combine physical, biological, social, and managerial conditions (table III-12 lists acreage for each setting):

(1) <u>Primitive</u> experiences occur in areas which have extremely high probability of isolation from human activity with difficult access by foot, a closeness to nature, with a high degree of challenge and risk in a large area of unmodified natural environment. Management controls are primarily off-site.



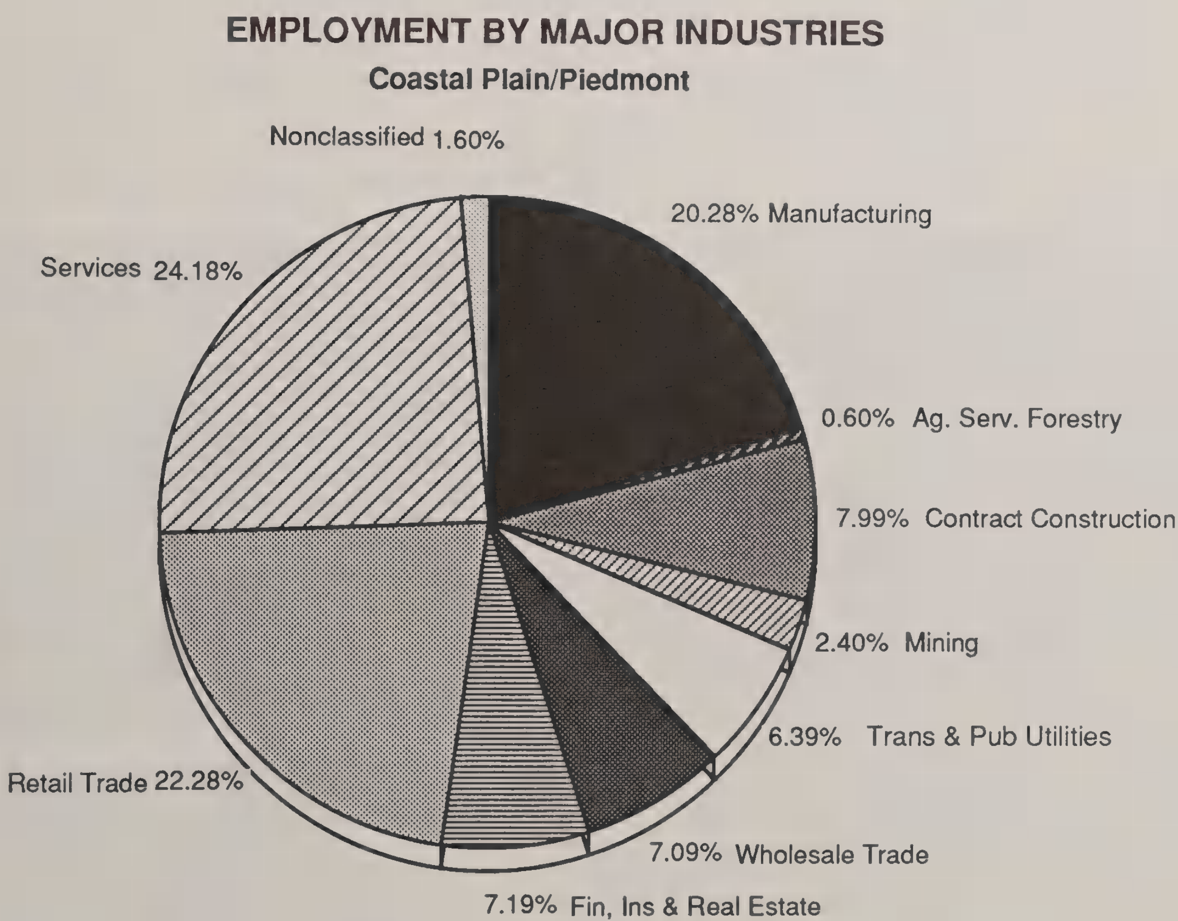


Figure III-3.--Employment by major industries

Table III-11.—Employment by major industries by State, 1983

	AL	FL	GA	LA	MS	NC	SC	TX	TOTAL
Ag Serv For & Fisheries	4,798	32,676	10,776	5,422	3,534	9,731	5,432	29,172	101,541
Mining	14,034	12,489	7,826	81,489	8,599	3,468	1,749	264,579	376,233
Contract Construction	76,355	315,649	135,850	98,535	35,888	133,277	103,309	469,457	1,368,320
Manufacturing	340,772	499,207	560,624	177,735	211,841	840,496	364,518	1,002,470	3,997,663
Transport & Other Pub Util	68,637	225,425	150,174	108,124	34,576	127,677	43,181	360,538	1,118,332
Wholesale Trade	75,177	242,531	168,346	90,708	41,046	133,975	52,575	436,860	1,231,218
Retail Trade	228,238	933,269	442,438	291,237	134,037	421,175	207,818	1,231,475	3,889,687
Finance Ins & Real Estate	65,106	315,403	134,214	85,087	36,489	110,414	56,683	430,524	1,233,920
Services	237,663	1,103,132	447,783	316,592	119,570	412,369	197,338	1,332,521	4,166,968
Non-classified	15,583	54,982	28,315	17,675	10,294	27,296	14,856	85,508	254,509
TOTAL	1,126,363	3,734,763	2,086,346	1,272,604	635,874	2,219,878	1,047,459	5,625,104	17,748,391

Table III-12.--Experience settings* (Approximate)

Forest	SPNM	SPM	RN	R
Alabama	5,000	8,000	230,000	500
Croatan/Uwharrie	83,000		116,000	
Florida	83,000	14,000	990,000	1,000
Francis Marion/Sumter	21,000	6,000	53,000	215,000
Kisatchie	33,000		528,000	3,000
Mississippi		44,000	950,000	146,000
Oconee			104,000	
Texas	41,000	104,000	524,000	4,000

*No acres in the Coastal Plain/Piedmont are classed primitive

Key: SPNM - Semi-primitive non-motorized
SPM - Semi-primitive motorized
RN - Road natural
R - Rural

(2) <u>Semi-primitive, non-motorized</u> experiences occur in areas which have high probability of isolation with a moderate to high degree of challenge and risk in a large area of natural or natural appearing environment with access by foot. Management controls may be present, but subtle.

(3) <u>Semi-primitive, motorized</u> experiences occur in areas which have moderate degrees of isolation, but some opportunity for vehicle use, risk, challenge and self-reliance in a predominately natural-appearing area of moderate size with limited access by road. Management controls are present with some dominant modifications.

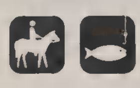
(4) <u>Roaded natural</u> experiences occur in areas which have about equal probability of isolation and social contact. Challenge and risk are not often present. Some easily noticed dominant modifications occur, but management controls harmonize with the natural environment, with convenient access by road.

(5) <u>Rural</u> experiences occur in areas which have high probability for social interaction. Convenience is more important than challenge. Modifications are fairly constantly observed, controls are obvious and numerous, and access is designed for ease and comfort.

Vegetation management can enhance or impair these settings, and thus affect experiences. This evaluation groups forest users into workers, neighbors and visitors (table III-13).

The table shows some possible experiences for each group in each setting. Many experiences can be obtained in any setting and individuals can be members of different user groups at different times. Workers include employees, contractors, permittees, and cooperators. Neighbors include adjacent landowners, permittees, and local community residents. Visitors are those who come to the forests for specific purposes, stay a short while (hours or days), then return home.

Table III-13--Experiences by user groups in different settings

	USERS		
SETTING	Workers (Types of Work)	Neighbors (Types of Benefits)	Visitors (Types of Activities)
Primitive 	Trail maintenance	Viewing, solitude, vicarious benefits	Hiking, nature study, fishing, canoeing, tent camping, solitude, walking
Semi-Primitive Non-Motorized 	Resource inventory, inspections, limited resource work	Viewing, solitude, vicarious benefits	Hiking, nature study, fishing, hunting, camping, horseback riding, canoeing, swimming, solitude, walking
Semi-Primitive Motorized 	Cultural treatments, resource manipulation, enforcement	Vehicular access, viewing, contact with others, vicarious benefits	Nature study, fishing, hunting, camping, pleasure driving, off-road vehicle use, boating, riding, gathering products
Roaded Natural 	Cultural treatments, resource control enforcement, maintenance of services, wide range of intensity of work	Vehicular access, viewing, frequent contact with others. gathering products, vicarious benefits	Fishing, hunting, camping with services, pleasure driving, off-road vehicle use, boating, riding, gathering products games and play, interpretive services, cycling, picnicking
Rural 	Resource control, resource marketing, transportation, economy, high intensity work	Rural comfort in proximity to urban services, viewing, recreation cabin use, contact with others dominates	Road tours, camping with full service and facilities, viewing man's works, boating, cycling, organized games, gathering products, picnicking

Environmental Consequences

CHAPTER IV

CHAPTER IV

ENVIRONMENTAL CONSEQUENCES

IN BRIEF

Part A describes the purposes of this chapter and defines the types of environmental effects analyzed. Parts B through M present the analysis of effects on each environmental element, and part N summarizes these effects for each alternative. Parts O through Q identify research needs, energy requirements, and conflicts with others. Parts R through T disclose unavoidable adverse effects, irreversible and irretrievable resource commitments, and relationships between short-term uses and long-term productivity.

A. INTRODUCTION

This chapter discloses the effects of each alternative on each environmental element described in chapter III, and forms the scientific basis for the mitigation measures and comparisons of alternatives in chapter II.

If done without clear guidelines and reasonable restrictions some vegetation management activities can damage our environment. Many potential problems, however, can be anticipated, so ways to prevent them or minimize their severity can be stated in advance. Management requirements and mitigation measures are the "do's" and don't's" that workers and managers must use to protect our environment as they perform vegetation management.

To clearly display them to the reader, effects of vegetation management are discussed separately for each environmetal element. Effects can be direct, indirect, or cumulative.

Direct effects occur at the same time and place as the actions that cause them. Their causes are usually obvious.

Indirect effects occur at a later time or different place than the actions that cause them. Their causes may not be obvious and may stem from effects on other environmental elements.

Cumulative effects are the combined effects of these actions with those of other past, present, and future actions. Cumulative effects can be on-site (confined to the project area) or off-site (felt outside the project area). Effects on vegetation or soil are chiefly on-site. Effects on water and air quality or wildlife and fish are commonly off-site.

1. Scope of Analysis

The Southern Region includes a variety of landscapes, plant communities, soil types and climatic conditions. In order to account for some of these gross differences, we divide the Region into three parts for analysis of vegetation

management activities. This environmental impact statement evaluates only the Coastal Plain/Piedmont part. See chapter III for a description of the Coastal Plain/Piedmont.

The area analyzed contains 4.6 million acres of national forests and national grasslands, and has a complex variety of environmental conditions. We evaluate area-wide effects, and, where possible, sub-area effects. In environmental analysis jargon, this approach is called "programmatic."

Within this broad area, site-specific vegetation management activities occur at hundreds of locations. Environmental effects from these projects vary with conditions on each project site. Many of these effects are predictable and are analyzed in this document. Other effects are unique to the site.

Recognizing this uniqueness, each project must be analyzed when proposed. The National Environmental Policy Act and Council on Environmental Quality Regulations describe a process called "tiering" to accomplish this evaluation. Tiering means the Forest Service will use this environmental statement and those accompanying Forest Land and Resource Management Plans as references when we conduct further analysis.

In chapter II, we explain requirements for further analysis (part E., 1., a.). Further analysis follows one of three possible paths:

If the analysis shows that management activities cause no significant effects to the human environment, it is documented in an <u>environmental assessment</u>.

If the analysis discloses significant environmental consequences, an <u>environmental impact statement</u> is prepared.

If there are no significant impacts and the activity is routine and past experience allows prediction of results, the activity is a <u>categorical exclusion</u>. An analysis is done, but an environmental document is not prepared.

This chapter describes environmental effects expected when methods (herbicide, manual, prescribed fire, mechanical, and biological) of vegetation management are used. Eight different ways (alternatives) to conduct the vegetation management program are evaluated. These approaches to doing work differ by:

1. Treating more or fewer acres either as a total or with individual methods.

2. Using or not using certain methods.

3. Varying the intensity of application of methods.

After reading about these effects and how they differ by alternative, the reader can refer back to chapter II, parts F, G, and H for comparison.

B. HUMAN HEALTH AND SAFETY

Discussion of human health and safety is presented in three parts:

1. Effects of herbicides. Herbicide effects on human health, which are evaluated in a risk assessment (appendix A), are summarized in this section.

2. Effects of prescribed fire. This section deals primarily with the analysis of risk to workers from herbicide residues present on fuels at the time of burning.

3. Effects of other methods of vegetation management. This section deals with the risk to workers of accidents during manual, mechanical, or biological vegetation management operations and during prescribed burning.

Each section contains information about how the analyses were performed, including a summary of exposure routes and amount of exposure, associated inherent risk of each tool, and an assessment of the resultant risk of exposing people to that tool.

The evaluation of risk has two major facets -- risk assessment and risk management. In addition to following the formal risk assessment process, this EIS presents management requirements and mitigation measures to manage (reduce) risk (chapter II).

1. Effects of Herbicides

Source of Information

The human health risk assessment (appendix A) contains an analysis of the potential adverse effects to human health of 11 herbicides and 3 additives. The risk assessment was prepared by Labat-Anderson Inc. (LAI). Data from USDA Forest Service Agriculture Handbook #633 (Sassman and others 1984) and supplement (Sassman & Jacobs 1986) were updated based on more recent information provided to the Environmental Protection Agency (EPA) during the ongoing pesticide re-registration process. In addition, background documents were prepared for light fuel oil (Weeks and others 1988a) and for imazapyr (Weeks and others 1988b). When available, only EPA validated data are used. No data invalidated by EPA are used.

In addition to consultation with EPA, both LAI and the Vegetation Management Team exhaustively searched the scientific literature concerning health effects of

herbicides. Inquiries were made of 21 library and toxicology data bases (DB) including: Medline, Toxline, Embase, Hazardous Substances DB, Registry of Toxic Effects of Chemical Substances DB, BIOSIS Previews, CAB (Commonwealth Agriculture Board) Abstracts DB, and Enviroline DB.

Four sections of the risk assessment apply to the analysis of human health effects.

Section 2 describes methods currently used to apply herbicides in the Southern Region.

Section 3 documents basic toxic properties of the chemicals (the hazard analysis).

Section 4 documents probable exposures of workers and the public to these chemicals (the exposure analysis) by combining information from section 2 with estimates of hours worked and chemical use-rates.

Section 5 combines predicted hazards and exposures to estimate the danger to workers and public (the risk assessment).

Hazard Identification

Human health effects are evaluated based on dose/time relationships. These relationships are expressed as:

Acute toxicity -- the potential of a chemical to cause adverse health effects when administered in a single dose.

Subchronic toxicity -- the potential of a small dose of herbicide or additive administered daily for a relatively short period of time (generally about 30 days) to cause adverse health effects.

Chronic toxicity -- the potential of a small dose of herbicide or additive administered daily over a long period of time to cause adverse health effects.

Herbicides available to consumers are formulated products which contain technical product (active ingredient) and other chemicals or water (inert ingredients). Testing to determine toxic properties is done in the laboratory. Most tests are done with active ingredients, not formulated products (the product as sold, including active and inert ingredients).

Some evaluated health effects related to toxicity are:

Mortality -- death of test animals, which suggests probability of human death. Herbicide or additive toxicity is determined by the amount of chemical that kills one-half of the animals tested. EPA categories of acute toxicity are very slightly toxic (large amounts of chemical are needed to kill an animal); slightly toxic; moderately toxic; and severely toxic (small amounts of chemical are needed to kill an animal) (appendix A, table 3-1).

Organ effects -- abnormal growth (size or shape) or observable malfunction of organs. Generally the liver, kidney, ovaries, and pancreas are closely monitored, though other organs are often studied.

Doses which cause organ effects are stated as amount of herbicide or additive per unit of body weight per unit of time (generally milligrams of chemical per kilogram of body weight per day).

Exposure and Dose Response

To understand exposure a distinction must be made -- exposure and dose are NOT the same thing. Exposure is the amount of substance which a person contacts in the environment. Dose is the amount of that substance which is taken into an organism (by breathing, eating, penetrating the skin, or any other route). Thus, dose can equal exposure, but normally it is smaller.

In section 4 of the risk assessment, exposure levels of workers and the public are computed. These levels cover the herbicides and additives proposed for use. Exposure estimates consider ways in which exposure occurs, such as specific public or worker activity, rate of herbicide application, size of treatment area, method of application, and physical characteristics of the chemical (persistence or drift potential).

Each of these exposures to chemicals is a series of possibilities running from no exposure to some theoretical maximum for each factor. The number of combinations for seasonal timing, method of application, chemical, length of field day, number of field days per year per worker, etc. is incredibly large. To reduce the number of possible combinations, three specific exposure scenarios are analyzed. Specific data are applied to each chemical and application method which approximate current and projected field activities (appendix A). The scenarios for which risk assessment is performed are:

The **typical** situation estimates average exposure of workers and other people during routine operations.

The **maximum** situation estimates the highest exposures of workers and other people when highest rates of chemical are applied by crew members who work a maximum number of hours per day for a maximum number of days per year.

An **accident** situation estimates exposure of workers and other people from direct exposure to herbicide resulting from a spill onto a worker or into a source of drinking water.

It is critical to remember that within each scenario ALL of the factors are relevant. The factors were mathematically modeled; changing any factor changes the scenario and the margin of safety projected for it. Risk is a function of dose -- but dose is critically dependent on several interrelated factors.

Potential movement of the herbicides and additives in the environment is estimated since this movement may also cause public exposure. Surface and subsurface movement (runoff and leaching) are estimated. Potential exposure due to drift of spray droplets is projected. Possible exposure as a result of either wildfire or deliberate burning (prescribed fire or firewood) is also predicted.

Exposure Information

Application rates and worker exposure times are based on actual projects and estimates of future use patterns in the Southern Region. Tables in the risk assessment show typical and maximum estimated hours per day a worker might be exposed, typical and maximum days per year, and typical and maximum amounts of chemical used per acre.

Estimates of public exposure are made for skin contact and consumption of food or water from forests treated with herbicides. Skin exposure is computed for visitors on-site and for off-site neighbors. People's dietary exposure is based on water, fish, meat from wildlife or cattle, vegetables, and berries.

Different exposure calculations account for differences in herbicide application methods; each method has its own potential to expose workers to herbicides. For example, a mechanical sprayer delivering herbicide 15 feet from the operator has far less likelihood of getting herbicide on the worker than does a sprayer held in the worker's hand. Also much less skin of a properly clothed worker (as in the typical operation) is exposed than with a worker not properly dressed (as for maximum exposure). The only route of exposure considered significant for workers in the typical operation is through the skin; however, in the maximum situation inhalation is also significant.

Accident projections are made using worst-case assumptions:

- large amounts of skin are bare or directly exposed;
- a person is sprayed with the full per-acre rate of application on all exposed skin;
- a full backpack tank of spray solution covers the worker's skin and soaks the clothing which is worn for the entire workday;
- a full tank of herbicide (100 gallons diluted for application) is spilled into a reservoir;
- a 5-gallon container of herbicide is spilled into a small pond; and,
- exposure occurs in both water scenarios by drinking 1 liter of contaminated water.

Risk Description

Section 5 of the risk assessment presents the risk of adverse health effects. EPA (1974 and 1986b), the American Conference of Governmental Industrial Hygienists (1984), the National Agricultural Chemicals Association (1985), the National Research Council (1983), Thomas (1986), and others have published standards for acceptable levels of chemicals in the environment, in ground water, or on foods. This EIS makes no value judgments (acceptable/unacceptable, safe/unsafe). It compares predicted risk with published standards to see if the herbicide or additive is more risky or less risky than the standard. Additional protective measures which reduce risk to a level less than the standard are noted as management requirements or mitigation measures in chapter II.

Three measures of risk are:

Margin of safety (MOS) -- compares the NOEL for laboratory animals and the dose estimated for different application operations. The NOEL (no observed effect level) is the dose of a chemical which can be administered to test animals causing no visible effects in subchronic testing. NOELS are evaluated for systemic (on the test animals) and reproductive (on their offspring) effects. According to Thomas (1986) acceptable levels of risk for a herbicide can be estimated. A safety factor of 10 based on test animal data, is used to predict human effects (between species variation). An additional factor of 10 is used to account for possible variations among humans (within species variation). If the NOEL divided by the dose results in a number greater than 100, a chemical is considered to pose an acceptable risk for the general population (excluding sensitive individuals). The higher this margin of safety, the lower the risk of adverse health effects. For example, if the NOEL is 100 mg/kg/day, then all doses of less than or equal to 1 mg/kg/day have margins of safety of 100 or greater

(poses less risk than the standard), while all doses greater than 1 mg/kg/day have less than a 100 fold MOS (poses a greater or unacceptable risk than suggested by the standard).

The relationship between exposure and dose is influenced by the rate at which the chemical penetrates the skin (or is inhaled or ingested); how soon it is washed off; its potential to be broken down in the body; and how efficiently body systems eliminate it.

Mutagenic potential -- the possibility that the herbicide or additive will cause a change in the basic information-carrying structure (DNA) in the cell's nucleus. This is of special concern in reproduction where altered genetic information might be inherited by offspring.

Evaluation of mutagenic potential is difficult. For some herbicides, no EPA-validated mutagenicity tests exist, or tests are insufficient to allow scientific conclusions. When no validated tests are available mutagenicity is assumed, and cancer potency values are used to indicate the degree of mutagenicity. This represents the worst-case assumption.

Cancer potency -- an estimate of the possibility that a single exposure or a lifetime exposure to a herbicide or additive might cause cancer.

Data Gaps

Gaps exist in our knowledge. Incompleteness of data results from registration laws, age of data (tests performed in the past may be judged inadequate by current registration standards), and results from two or more tests which disagree. The Council on Environmental Quality regulations discuss the process for evaluating incomplete and unavailable information (40 CFR 1502.22(a) & (b)).

Data gaps which result in uncertainty about reasonably foreseeable significant adverse human health effects include the following:

1. Human toxicity data; moral restrictions and laws generally prohibit such tests. Animal tests are evaluated and models are used to project probable effects on humans, but human toxicity data are lacking.

2. Data on field worker exposure are available only for 2,4-D, 2,4-DP, dicamba, picloram, and triclopyr. Neither dermal penetration rates nor exposure estimates using current technology and mitigation are available for the other herbicides or additives evaluated.

3. Oncogenicity (ability to cause either cancerous or non-cancerous tumors) data for 2,4-D, 2,4-DP, fosamine, glyphosate, imazapyr, light fuel oil, limonene, picloram, and triclopyr are unavailable or there is scientific disagreement regarding oncogenicity potential. Mutagenicity data are incomplete (table 3-5, appendix A).

4. The effects on human health of smoke inhalation is another area of uncertainty. Limited evaluation of the risk to workers or the public from unadulterated smoke or from smoke resulting when the fuels have been previously treated with herbicides has been done. While current studies indicate no additional hazard from fuels treated with herbicides, repeated inhalation of unadulterated smoke has been suggested as a cause of some cases of emphasema and lung cancer.

5. Experimental information is not available on the public's exposure to herbicides applied using current methods.

6. Field studies on residue levels in plants or animals in and around treatment areas are lacking for several herbicides. Comparison of data is very difficult because existing studies use different analytical methods.

7. Information about synergistic effects of herbicide combinations with other herbicides and with inert ingredients is unavailable.

8. Data relating to cumulative effects are unavailable.

There have been recent changes about how to evaluate incomplete or unavailable data. The Council on Environmental Quality issued regulations in November 1978 (40 CFR 1502.22) which required that a worst case analysis be performed to estimate risk of relevant missing information. In 1986, they modified this requirement to allow analysis of "... reasonably foreseeable significant adverse effects to the human environment ..." (40 CFR 1502.22).

Recognizing that there are significant incomplete or unavailable data, we have prepared a risk assessment (appendix A) using the 1986 requirements. In the risk assessment, we evaluate maximum (or extreme) and accident scenarios which are similar to the worst case analyses required under the earlier regulations. Thus, we have attempted to address both sets of regulations in our analysis.

40 CFR 1502.22(b) requires that when costs for filling data gaps are exorbitant or, when means to obtain the data are

unknown, the agency's evaluation of impacts must be based on theoretical approaches or research methods generally accepted in the scientific community. This analysis uses a risk assessment to compensate for missing data (appendix A). This approach which "is firmly based in scientific considerations... is a process of weighing alternatives and selecting the most appropriate actions" (National Research Council, 1983).

Throughout the analyses, conservative estimates (greatest risk to humans) were used to approximate missing or incomplete data. The risk assessment provides modified worst case analyses (maximum and accident scenarios) which present reasonably foreseeable scenarios in which extreme exposure to herbicide occurs.

Each test needed to provide data which are currently unavailable or incomplete costs from tens of thousands (mutagenicity, worker exposure, etc.) to over a million dollars (chronic toxicity, oncogenicity, etc.). If all tests were performed, direct costs would be tens of millions of dollars. In addition, by delaying vegetation management indefinitely to complete all testing, the public would suffer increased hazard from wildfire, and production of goods and services would be reduced (see analysis of the effects of Alternative A). The Forest Service considers that delay-caused fire hazard, delay-caused deterioration of services, and costs entailed to fill these data gaps are too great to justify postponing issuance of this environmental impact statement.

Despite the magnitude of this potential investment, the inherent difficulty of analysis of human health effects remains. Studies on animals are modeled to approximate human health effects, but, especially for chronic effects, the relevance of 2 to 4-year studies on animals when compared with a 60+ year life span for a human has been seriously questioned. Also, the relevance of the concept of chronic exposure when applied to relatively non-persistent herbicides is questionable.

Acute Toxicity

Acute toxicity is the potential to cause death when the dose is by mouth (acute oral toxicity) or by skin (acute dermal toxicity). Estimates of human toxicity are based on acute toxicity values (single-dose mortality) determined for test animals in laboratory experiments using pure (technical grade) herbicides and, generally, one herbicide at a time.

The more toxic the product, the less is required to cause death. A dose of more than a pint (16 fluid oz) of a <u>very slightly toxic</u> herbicide is required to cause the death of an average adult (150 lb) human. Similarly, between 1 fluid ounce and a pint of <u>slightly toxic</u> herbicide would kill an

adult; between a teaspoonful (1/6 fl oz) and one fluid oz of a moderately toxic herbicide is lethal; but, less than a teaspoonful of severely toxic herbicide or additive is required to cause death.

Acute oral toxicities of the chemicals are (appendix A, table 3-2):

- Very slightly toxic--Diesel oil, fosamine, imazapyr, kerosene, limonene, picloram and sulfometuron methyl.
- Slightly toxic--Dicamba, glyphosate, hexazinone, tebuthiuron, triclopyr, and 2,4-DP.
- Moderately toxic--2,4-D.
- Severely toxic--none.

Acute dermal toxicities are reported to be (appendix A, table 3-3):

- Very slightly toxic--Dicamba.
- Slightly toxic--2,4-D, 2,4-DP, Diesel oil, glyphosate, hexazinone, imazapyr, kerosene (tentative), limonene (tentative), picloram, sulfometuron methyl, and triclopyr.
- Moderately toxic--Fosamine and Tebuthiuron.
- Severely toxic--None.

Irritation

It is also necessary to know if a herbicide is an irritant: does it cause skin or eye problems? The risk assessment shows the amount of each chemical causing primary dermal or primary eye irritation. EPA (1974) categories are:

- IV- no irritation to the eyes; mild or slight skin irritation at 72 hours.
- III- No corneal opacity; moderate skin irritation at 72 hours.
- II- Corneal opacity reversible within 7 days; severe skin irritation at 72 hours.
- I- Irreversible corneal opacity at 7 days; corrosive to the skin.

Primary dermal irritations by the chemicals are (appendix A, table 3-3):

- Category IV--2,4-DP (Weedone formulation), dicamba, fosamine, glyphosate, imazapyr, kerosene, limonene, picloram, tebuthiuron and triclopyr.

- Category III--2,4-D, hexazinone and sulfometuron methyl.

- Category II--Diesel oil.

- Category I--None.

Primary eye irritations by the chemicals are (appendix A, table 3-3):

- Category IV--2,4-DP, diesel oil, kerosene and tebuthiuron.

- Category III--Dicamba, glyphosate, imazapyr, picloram and sulfometuron methyl

- Category II--Hexazinone and triclopyr.

- Category I--2,4-D.

- No data--Fosamine and limonene.

No Observed Effect Levels

Systemic NOELs range from a low of 1 mg/kg for 2,4-D to a high of 500 mg/kg for imazapyr, but only 2,4-D, sulfometuron methyl, and triclopyr are less than 5 mg/kg (appendix A, table 3-2). Reproductive NOELs are reported between 2.5 mg/kg (dicamba and triclopyr) and 751 mg/kg (light fuel oils) (appendix A, table 3-2).

Effects of Inert Ingredients

An inert ingredient is not necessarily chemically unreactive; it is simply not the active ingredient in the formulation. EPA's Office of Pesticide Programs (EPA 1987) has identified about 1,200 inert ingredients currently used in pesticides, and they have categorized these chemicals based on their ability to cause chronic human health effects as follows:

- List 1--Inerts of toxicological concern: approximately 50 chemicals shown to be carcinogens, developmental toxicants, neurotoxins, or potential ecological hazards which merit highest priority for regulatory action.

- List 2--Potentially toxic inerts: about 50 chemicals with toxicity data suggesting, but not confirming possible chronic health effects, or having chemical structures similar to chemicals on list 1. They are high priority for testing.

- List 3--Inerts of unknown toxicity: approximately 800 chemicals were placed here "... if there was no basis for listing it on any of the other three lists." Priority for further testing is low.

- List 4--Inerts of minimal concern: about 300 chemicals generally regarded as innocuous. Priority for testing is low.

Inert ingredient information is presented in the risk assessment (appendix A, table 3-8). None of the chemicals evaluated is on List 1 and only one chemical (kerosene) is on List 2. One additive is unclassified and the remaining inert substances are on list 3 or 4. In all cases, formulated products (the products as purchased which include both active and inert ingredients) have lower risk of acute toxic effects than the active ingredient alone.

Current Forest Service policy is to permit use of formulations containing List 3 or List 4 inerts in all appropriate situations. Formulations containing List 2 chemicals are used only when no formulation with only List 3 or List 4 inert ingredients are available meet project objectives, and only after an evaluation of the inert ingredient shows that health risks are acceptable. Formulations containing List 1 inerts are not used.

Exposure Levels

Tables 4-25 through 4-40 in the risk assessment display projected public, worker and accident exposure levels. Important reference points are discussed below.

Berry pickers exposed to 0.14 mg/kg/day fosamine in the maximum exposure scenario represent the highest projected level of public exposure. Levels less than 0.00001 mg/kg/day are projected for public dermal exposure to drift of 2,4-DP and picloram, and for public dietary exposure to imazapyr (via fish), limonene (fish), picloram (fish), and sulfometuron methyl (water, fish, or meat) when these chemicals are applied at typical rates. Many worker exposure levels in the maximum scenario are greater than 1 mg/kg/day (a very high level of exposure). Maximum scenario exposures range from 1.5 to 100 or more times as great as typical exposure levels. For workers in normal settings, both typical and maximum scenarios show the mixer/loader and the backpack (broadcast foliar) applicator have the greatest exposure.

Accidental spills involving workers cause the greatest individual exposure. The range is from 1020 mg/kg/day for diesel oil to 0.29 mg/kg/day for picloram. No other accident for any other chemical shows greater than 0.5 mg/kg/day exposure.

Typical Public Scenario

Tables IV-1 through IV-5 display margin of safety data. These tables summarize data presented in tables 5-8 through 5-23 of appendix A (risk assessment).

Comparison of estimated MOSs for typical public exposures (table IV-1) indicates that no member of the public, including sensitive individuals, should be affected by the herbicides or additives proposed for use in Region 8. This generalization applies to both systemic and reproductive effects.

Maximum Public Scenario

For the maximum public exposure scenario (table IV-2) only berry pickers are at risk. Systemic MOSs are greater than 100 for all chemicals used in this scenario except for 2,4-D (amine and ester), triclopyr (amine and ester), and 2,4-DP. For the reproductive MOS, only berry pickers are at risk and only in areas recently treated with 2,4-D ester, 2,4-DP, dicamba, and triclopyr (amine and ester) which have MOSs of less than 100. Berries sprayed with these products should not be eaten.

No public exposure for either the typical or maximum aerial application scenario has a MOS less than the 100-fold criterion.

Typical Worker Scenario

Only 2,4-D and tebuthiuron are of concern for workers when applying herbicides with backpack sprayer (table IV-3). Each shows at least one systemic or reproductive MOS of less than 100.

Mixer/loaders and applicator/mixer/loaders are at risk of showing systemic toxic effects when either the ester or amine of 2,4-D is used. Also at risk are workers doing broadcast foliar treatments, and those applying the amine formulation as a cut-surface treatment. The reproductive MOS is less than 100 for the ester and amine 2,4-D formulations broadcast onto leaves using backpack sprayers. Tebuthiuron MOSs for reproductive and systemic effects (less than 100) indicate a risk of adverse effects for unprotected workers who repeatedly use it in broadcast foliar treatments with a backpack sprayer.

Without additional mitigation, 2,4-D, 2,4-DP, and tebuthiuron pose unacceptable health risks to applicators in several of the scenarios. Mitigation can include reducing the acreage sprayed by an individual applicator, wearing full body waterproof coveralls, or reducing the number of days per year an applicator sprays these two herbicides. Reducing exposure will improve the MOS.

Table IV-1.—Public risk in the typical scenario; systemic and reproductive MOS values are used to compare risk levels

SYSTEMIC MOS

	2,4-D AMINE	2,4-D ESTER	2,4-DP	DICAM	DIESE	FOSAM	GLYPH	HEXAZ	IMAZA	KEROS	LIMON	PICLO	SULFO	TEBUT	TRICLOPYR AMINE	TRICLOPYR ESTER
Dermal																
Drift	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
Onsite	I	LO	I	I	I	I	I	I	I	I	I	I	I	I	I	I
Dietary																
Water	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
Fish	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
Meat	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
Vegetable	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
Berry pickers	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
Based on a systemic NOEL of:	1	1	5	25	7.38	25	31	10	500	28	227	7	2.5	12.5	2.5	2.5

REPRODUCTIVE MOS

	2,4-D AMINE	2,4-D ESTER	2,4-DP	DICAM	DIESE	FOSAM	GLYPH	HEXAZ	IMAZA	KEROS	LIMON	PICLO	SULFO	TEBUT	TRICLOPYR AMINE	TRICLOPYR ESTER
Dermal																
Drift	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
Onsite	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
Dietary																
Water	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
Fish	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
Meat	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
Vegetable	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
Foraged berries	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
Based on reproductive NOEL of:	5	5	6.25	2.5	751	500	10	50	300	751	227	50	25	20	2.5	2.5

KEY: I = Insignificant risk (MOS exceeds 1000); LO = Low risk (MOS is between 100 and 1000); HI = High risk (MOS is between 1 and 100); VH = Very high risk (MOS is less than 1); N = Not applicable

NOTE: Chemical names are abbreviated in tables IV-HH1 through IV-HH5 as follows: DICAM = dicamba, DIES = diesel oil, FOSAM = fosamine, GLYPH = glyphosate, HEXAZ = hexazinone, IMAZA = imazapyr, KEROS = kerosene, LIMON = limonene, PICLO = picloram, SULFO = sulfometuron methyl, and TEBUT = tebuthuron.

Table IV-2.—Public risk in the maximum scenario; systemic and reproductive MOS values are used to compare risk levels

SYSTEMIC MOS	2,4-D AMINE	2,4-D ESTER	2,4-DP	DICAM	DIESE	FOSAM	GLYPH	HEXAZ	IMAZA	KEROS	LIMON	PICLO	SULFO	TEBUT	TRICLOPYR AMINE	TRICLOPYR ESTER
Public																
Dermal																
Drift	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
Onsite	LO	LO	I	I	I	I	I	I	I	I	I	I	I	I	I	I
Dietary																
Water	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
Fish	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
Meat	LO	LO	LO	I	LO	I	I	I	I	I	I	I	I	I	LO	LO
Vegetable	LO	LO	I	I	I	I	I	I	I	I	I	I	I	I	I	I
Berry pickers	HI	HI	HI	LO	LO	LO	LO	LO	I	LO	I	LO	LO	LO	HI	HI
Based on a systemic NOEL of:	1	1	5	25	7.38	25	31	10	500	28	227	7	2.5	12.5	2.5	2.5

REPRODUCTIVE MOS	2,4-D AMINE	2,4-D ESTER	2,4-DP	DICAM	DIESE	FOSAM	GLYPH	HEXA	IMAZA	KEROS	LIMON	PICLO	SULFO	TEBUT	TRICLOPYR AMINE	TRICLOPYR ESTER
Public																
Dermal																
Drift	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
Onsite	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
Dietary																
Water	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
Fish	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
Meat	LO	LO	LO	LO	I	I	I	I	I	I	I	I	I	I	LO	LO
Vegetable	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
Foraged berries	LO	HI	HI	HI	I	I	LO	LO	I	I	I	I	I	LO	HI	HI
Based on reproductive NOEL of:	5	5	6.25	2.5	751	500	10	50	300	751	227	50	25	20	2.5	2.5

KEY: I = Insignificant risk (MOS exceeds 1000); LO = Low risk (MOS is between 100 and 1000); HI = High risk (MOS is between 1 and 100); VH = Very high risk (MOS is less than 1); N = Not applicable

Table IV-3.—Worker risk in the typical scenario; systemic and reproductive MOS values are used to compare risk levels

SYSTEMIC MOS	2,4-D AMINE	2,4-D ESTER	2,4-DP	DICAM	DIESE	FOSAM	GLYPH	HEXAZ	IMAZA	KEROS	LIMON	PICLO	SULFO	TEBUT	TRICLOPYR AMINE	TRICLOPYR ESTER
Aerial																
Pilot	LO	LO	I	N	I	LO	I	I	I	I	I	I	I	I	LO	I
Mixer/loader	HI	HI	I	N	LO	LO	I	LO	I	LO	I	I	I	LO	LO	LO
Observer	I	I	I	N	I	I	I	I	I	I	I	I	I	I	I	I
Mechanical ground																
Applicator	LO	LO	I	I	LO	I	I	I	I	I	I	I	I	I	LO	LO
Mixer/loader	HI	HI	I	I	LO	I	I	LO	I	LO	I	I	I	I	LO	LO
Appl/Mix/Load	HI	HI	I	I	LO	I	I	LO	I	LO	I	I	I	I	LO	LO
Manual ground																
Backpack spray	HI	HI	I	N	N	LO	LO	LO	I	LO	I	I	LO	HI	LO	LO
Basal stem	N	LO	I	N	LO	N	N	N	N	I	I	N	N	N	N	LO
Soil spot	N	N	N	N	N	N	N	LO	N	N	N	N	N	I	N	N
Cut surface	HI	N	N	I	N	N	LO	N	I	N	N	I	N	N	LO	N
Based on a systemic NOEL of:	1	1	5	25	7.38	25	31	10	500	28	227	7	2.5	12.5	2.5	2.5

REPRODUCTIVE MOS	2,4-D AMINE	2,4-D ESTER	2,4-DP	DICAM	DIESE	FOSAM	GLYPH	HEXAZ	IMAZA	KEROS	LIMON	PICLO	SULFO	TEBUT	TRICLOPYR AMINE	TRICLOPYR ESTER
Aerial																
Pilot	LO	LO	I	N	I	I	I	I	I	I	I	I	I	I	LO	I
Mixer/loader	LO	LO	I	N	I	I	I	I	I	I	I	I	I	I	LO	LO
Observer	I	I	I	N	I	I	I	I	I	I	I	I	I	I	I	I
Mechanical ground																
Applicator	LO	LO	I	LO	I	I	I	I	I	I	I	I	I	I	LO	LO
Mixer/loader	LO	LO	I	LO	I	I	I	I	I	I	I	I	I	I	LO	LO
Appl/Mix/Load	LO	LO	I	LO	I	I	I	I	I	I	I	I	I	I	LO	LO
Manual ground																
Backpack spray	HI	HI	I	N	N	I	LO	I	I	I	I	I	I	HI	LO	LO
Basal stem	N	LO	I	N	I	N	N	N	N	I	I	N	N	N	N	LO
Soil spot	N	N	N	N	N	N	N	I	N	N	N	N	N	I	N	N
Cut surface	LO	N	N	LO	N	N	LO	N	I	N	N	I	N	N	LO	N
Based on reproductive NOEL of:	5	5	6.25	2.5	751	500	10	50	300	751	227	50	25	20	2.5	2.5

KEY: I = Insignificant risk (MOS exceeds 1000); LO = Low risk (MOS is between 100 and 1000); HI = High risk (MOS is between 1 and 100); VH = Very high risk (MOS is less than 1); N = Not Applicable

Table IV-4.—Worker risk in the maximum scenario; systemic and reproductive MOS values are used to compare risk levels

SYSTEMIC MOS	2,4-D AMINE	2,4-D ESTER	2,4-DP	DICAM	DIESE	FOSAM	GLYPH	HEXAZ	IMAZA	KEROS	LIMON	PICLO	SULFO	TEBUT	TRICLOPYR AMINE	TRICLOPYR ESTER
Aerial																
Pilot	HI	HI	I	N	LO	LO	LO	LO	I	LO	I	I	LO	LO	LO	HI
Mixer/loader	HI	HI	I	N	LO	HI	LO	LO	I	HI	I	I	LO	HI	HI	HI
Observer	LO	LO	I	N	I	I	I	I	I	I	I	I	I	I	I	I
Mechanical ground																
Applicator	HI	HI	I	LO	HI	HI	HI	HI	I	HI	LO	I	LO	HI	HI	HI
Mixer/loader	HI	HI	I	LO	HI	HI	HI	HI	I	HI	LO	I	LO	HI	HI	HI
Appl/Mix/Load	HI	HI	I	LO	HI	HI	HI	HI	I	HI	LO	I	LO	HI	HI	HI
Manual ground																
Backpack spray	HI	HI	LO	N	N	HI	HI	HI	I	HI	LO	I	HI	HI	HI	HI
Basal stem	N	HI	I	N	HI	N	N	N	N	LO	I	N	N	N	N	LO
Soil spot	N	N	N	N	N	N	N	LO	N	N	N	N	N	I	N	N
Cut surface	HI	N	N	LO	N	N	LO	N	I	N	N	I	N	N	LO	N
Based on a systemic NOEL of:	1	1	5	25	7.38	25	31	10	500	28	227	7	2.5	12.5	2.5	2.5

REPRODUCTIVE MOS	2,4-D AMINE	2,4-D ESTER	2,4-DP	DICAM	DIESE	FOSAM	GLYPH	HEXAZ	IMAZA	KEROS	LIMON	PICLO	SULFO	TEBUT	TRICLOPYR AMINE	TRICLOPYR ESTER
Aerial																
Pilot	LO	HI	I	N	I	I	LO	LO	I	I	I	I	I	LO	LO	HI
Mixer/loader	HI	HI	I	N	I	I	HI	LO	I	I	I	I	I	LO	HI	HI
Observer	I	I	I	N	I	I	I	I	I	I	I	I	I	I	I	I
Mechanical ground																
Applicator	HI	HI	I	HI	I	I	HI	HI	I	LO	LO	I	I	LO	HI	HI
Mixer/loader	HI	HI	I	HI	I	I	HI	HI	I	LO	LO	I	I	LO	HI	HI
Appl/Mix/Load	HI	HI	I	HI	I	I	HI	HI	LO	LO	LO	I	I	HI	HI	HI
Manual ground																
Backpack spray	HI	HI	LO	N	N	LO	HI	HI	LO	LO	LO	I	LO	HI	HI	HI
Basal stem	N	LO	I	N	I	N	N	N	N	I	I	N	N	N	N	LO
Soil spot	N	N	N	N	N	N	N	I	N	N	N	N	N	I	N	N
Cut surface	HI	N	N	HI	N	N	HI	N	I	N	N	I	N	N	LO	N
Based on reproductive NOEL of:	5	5	6.25	2.5	751	500	10	50	300	751	227	50	25	20	2.5	2.5

KEY: I = Insignificant risk (MOS exceeds 1000); LO = Low risk (MOS is between 100 and 1000); HI = High risk (MOS is between 1 and 100); VH = Very high risk (MOS is less than 1); N = Not applicable

Table IV-5.—Human risk in the accident scenario; systemic and reproductive MOS values are used to compare risk levels

SYSTEMIC MOS	2,4-D AMINE	2,4-D ESTER	2,4-DP	DICAM	DIESE	FOSAM	GLYPH	HEXAZ	IMAZA	KEROS	LIMON	PICLO	SULFO	TEBUT	TRICLOPYR AMINE	TRICLOPYR ESTER
Spill onto worker	VH	VH	HI	VH	VH	VH	VH	VH	HI	VH	VH	HI	VH	N	VH	VH
Accidental spray	HI	HI	I	LO	HI	HI	LO	HI	I	HI	I	I	LO	HI	HI	HI
Spill into water																
Ground	HI	HI	LO	I	LO	LO	I	LO	I	I	I	I	HI	LO	HI	HI
Air	LO	LO	I	N	I	I	I	I	I	I	I	I	I	I	LO	LO
Based on a systemic NOEL of:	1	1	5	25	7.38	25	31	10	500	28	227	7	2.5	12.5	2.5	2.5

REPRODUCTIVE MOS	2,4-D AMINE	2,4-D ESTER	2,4-DP	DICAM	DIESE	FOSAM	GLYPH	HEXAZ	IMAZA	KEROS	LIMON	PICLO	SULFO	TEBUT	TRICLOPYR AMINE	TRICLOPYR ESTER
Spill onto worker	VH	VH	HI	VH	VH	HI	VH	VH	HI	HI	VH	LO	VH	N	VH	VH
Accidental spray	HI	HI	I	HI	I	LO	HI	LO	I	I	I	I	I	HI	HI	HI
Spill into water																
Ground	LO	LO	LO	LO	I	I	LO	I	I	I	I	I	LO	LO	HI	HI
Air	I	I	I	N	I	I	I	I	I	I	I	I	I	I	LO	LO
Based on reproductive NOEL of:	5	5	6.25	2.5	751	500	10	50	300	751	227	50	25	20	2.5	2.5

Ground spill is assumed to be 5 gal into a pond; air spill is assumed to be 100 gal into a reservoir. KEY: I = Insignificant risk (MOS exceeds 1000); LO = Low risk (MOS is between 100 and 1000); HI = High risk (MOS is between 1 and 100); VH = Very high risk (MOS is less than 1); N = Not applicable

Maximum Worker Scenario

For workers applying herbicides in the maximum exposure scenario (table IV-4), several chemicals are of concern. The systemic MOSs for 2,4-D (amine and ester), diesel oil, fosamine, glyphosate, hexazinone, kerosene, tebuthiuron, and triclopyr (amine and ester) all have at least one high risk worker exposure (failed to exceed an MOS of 100). Reproductive MOSs also fail to exceed 100 for some 2,4-D, dicamba, glyphosate, hexazinone, tebuthiuron, and triclopyr application methods.

Accident Scenario

In the accident scenario several exposures are of concern (table IV-5). For systemic effects, all spills directly onto workers who did not immediately wash had either high or very high risk levels. When a person is accidentally sprayed, 2,4-D, diesel, fosamine, hexazinone, kerosene, tebuthiuron, and triclopyr pose high risks. MOSs for a ground spill (5 gallons into a pond) of 2,4-D (amine and ester), sulfomturon methyl, and triclopyr (amine and ester) have MOSs less than 100 (greater risk than the standard). All of the MOSs projected for aerial spills are greater than 100 (less risk than the standard).

For reproductive effects, all spills onto workers have MOSs below 100 except for picloram. Granular tebuthiuron was not evaluated. For spills into water, only triclopyr (amine or ester) has a MOS of less than 100.

Herbicide Oncogenicity

An analysis of maximum cancer risk was performed for 2,4-DP which has positive laboratory oncogenicity studies; for the light fuel oils (diesel and kerosene) which contain small amounts of materials known or suspected of causing cancer; and for the herbicides 2,4-D (amine and ester formulations), glyphosate and picloram for which there is scientific uncertainty about their ability to cause cancer.

There is no evidence to show that any of the other chemicals could cause cancer. However, data relating to fosamine, triclopyr, and limonene are unavailable, and imazapyr's data are incomplete. The remaining herbicides all have negative studies showing no effect.

Computation of lifetime cancer risk to the public from the seven chemicals evaluated (table IV-6 and appendix A, table 5-26) showed no risk greater than 2 in 10,000,000. Compare this with the values presented in table 5-28 of the risk assessment. The worst risk estimated for any of these chemicals is only 1/35th the risk of getting cancer from exposure to a single x-ray.

However, lifetime cancer risk to workers (table IV-6; based on appendix A, table 5-26) is greater than 1 in 1,000,000 for workers in all categories of application of 2,4-D and for backpack sprayer application of 2,4-DP. All other

Table IV-6.--Lifetime cancer risk

	2,4-D AMINE	2,4-D ESTER	2,4-DP	DIESE	GLYPH	KEROS	PICLO
Public							
Dermal							
Drift	L	L	L	L	L	L	L
Onsite	L	L	L	L	L	L	L
Dietary							
Water	L	L	L	L	L	L	L
Fish	L	L	L	L	L	L	L
Meat	L	L	L	L	L	L	L
Vegetable	L	L	L	L	L	L	L
Berry pickers	L	L	L	L	L	L	L
Workers							
Aerial							
Pilot	G	L	L	L	L	L	L
Mixer/loader	G	G	L	L	L	L	L
Observer	L	G	L	L	L	L	L
Mechanical ground							
Applicator	G	G	L	L	L	L	L
Mixer/loader	G	G	L	L	L	L	L
Appl/Mix/Load	G	G	L	L	L	L	L
Manual ground							
Backpack	G	G	G	NA	L	L	L
Basal stem	NA	G	L	L	NA	L	NA
Soil spot	NA	NA	NA	NA	NA	NA	NA
Cut surface	G	NA	NA	NA	L	NA	L

KEY: G = Risk greater than 1 in a million; L = Risk less than 1 in a million; NA = Not Applicable

evaluations for cancer potency showed risks to the worker of less than 1 in 1,000,000 (fewer than 1 in 1,000,000 workers are expected to get cancer).

Mutagenicity

Glyphosate, imazapyr, and sulfometuron methyl have tested negative for mutagenicity. Hexazinone, dicamba, picloram, tebuthiuron, and triclopyr are nonmutagenic in the majority of assays and pose only slight to negligible mutagenic risk. Fosamine presents a very slight risk of causing mutagenic effects. No mutagenicity testing has been updated by EPA for limonene. The Food and Drug Administration, however, reports that it is "generally regarded safe" as a food additive (appendix A text and table 3-6).

Both 2,4-D and 2,4-DP have shown mixed mutagenicity test results. They do not pose significant risk of human gene mutation (Sassman and others 1984). However, because of the mixed data on mutagenicity, both are considered to pose a mutagenic risk equivalent to their cancer potency. EPA has requested more testing.

Diesel oil and kerosene also present mixed results. Both contain small amounts of the carcinogenic compounds benzene and benzo(a)pyrene. They are, therefore, believed to have the same low-order risk of causing heritable mutation as is reported for their cancer potency (Weeks and others 1988).

Bioaccumulation

Bioaccumulation is the process whereby a chemical is concentrated in tissue at a level greater than in the environment (Ottoboni 1984). To bioaccumulate a chemical it must be absorbed into the body at a rate greater than it is eliminated (either through chemical breakdown or via excretion). Simple storage in cells is not bioaccumulation; the concept of storage does not imply any time frame (temporary or permanent). Bioaccumulation is a dynamic equilibrium process; it is not instantaneous but requires that the body be allowed time to come to an equilibrium and later to improve on that equilibrium.

Table 3-4 in the risk assessment shows the elimination rates reported for nine of the chemicals: 2,4-D, 2,4-DP, dicamba, fosamine, glyphosate, hexazinone, imazapyr, picloram, and triclopyr. Elimination rates for diesel oil, kerosene, limonene, sulfometuron methyl, and tebuthiuron are not available at present. Elimination varied from 100 percent (2,4-D [rat/5 days], dicamba [rat/48 hours], fosamine [rat/72 hours], and hexazinone [rat/72 hours] to a low of only 74 percent (2,4-DP 74-82 percent/rat/4 days). Some herbicide had not been eliminated at the termination of the study for: glyphosate (8 percent/rabbit/5 days), imazapyr (13 percent/rat/24 hours), picloram (10 percent/dog/48 hours and 4 percent/unspecfied test animal/24 hours), and triclopyr (9-17 percent/rat/unspecified time). The most

rapid elimination reported is for hexazinone (93 percent/rat/2 hours) while the slowest is shown above for 2,4-DP.

It is unclear from the studies if these amounts of not-eliminated material represent the lowest expected level at which equilibrium is established or if further elimination continued after the termination of the studies. The classic concepts of chemical half-life in the organism and bioaccumulation as permanent storage conflict and the controversy is unresolved. Bioaccumulation in the popular sense of continuous addition of new chemicals to an overwhelming burden does not appear to occur with these herbicides. The bodies of the test animals responded to exposure by eliminating the herbicides, not by permanently adding them to a previously accumulated stockpile of other chemicals. The limited number of exposure studies performed on field workers support this conclusion when applied to humans (appendix A).

Synergism

Synergistic effects of chemicals are unpredictable effects which occur from exposure to two or more chemicals either simultaneously or within a relatively short period. To be considered synergistic an effect must either be unpredictable from the known toxicological effects of the chemicals involved or be greater than the sum of the effects of each agent given alone.

The herbicide mixtures evaluated for the Southern Region's vegetation management program have not shown synergistic effects in humans who have used them in other applications, with the single exception that 2,4-D + picloram mixtures have been reported to cause skin irritation.

The toxic effects of possible herbicide combinations other than those commercial mixtures registered by EPA have not been studied. Time and money normally limit toxicity testing to the highest priority -- evaluation of the toxic effects of each chemical alone. Based on the limited amount of data available about the effects of herbicide combinations, it is possible but very unlikely that toxicologically significant synergistic effects could occur from exposure to two or more of the chemicals evaluated (appendix A).

There are several reasons which make the probability of synergism occurring extremely small. Herbicide residue in plants and soil do not persist from application to application. This results from the relatively short persistence and the relatively infrequent usage of herbicides on each site. The herbicides are rapidly excreted from the body. Exposure to two or more chemicals at the same time is likely only in cases where those

chemicals are combined in a single spray mixture. Workers having frequent contact with different herbicides are exposed to some risk of synergism. Public exposure to forestry herbicides should be minimal and extremely infrequent.

The Environmental Protection Agency's guidelines for the health risk assessment of chemical mixtures (EPA 1986a) reflect the problem of missing and unavailable data with respect to synergism. While not recommending any specific process for risk assessment, they do consistently explain the use of additive models which do not recognize possible effects greater than those caused by the known effects of the chemicals in the mixture.

2. Effects of Prescribed Fire

Brown-and-Burn

Brown-and-burn combines the use of herbicides and fire. Herbicide is applied, the vegetation is allowed to dry for 30 to 100 or more days, and then prescribed fire is used to reduce the above-ground fuel load and open the site for reforestation.

Because of concerns about the effect burning herbicide-treated vegetation might have on the health of the public and workers, two brown-and-burn scenarios are evaluated in the risk assessment (appendix A). This analysis has two purposes; to evaluate if 30 days is a sufficient interval to ensure that worker and public risk is acceptable, and to evaluate the potential health risk resulting from wildfire occurring immediately after herbicide application.

Fuel load, smoke density, and amount of fuel consumed are based on Southern Region data for representative fuel types. Published rates for photodecomposition are used to

estimate the amount of herbicide remaining intact at the time of fire. Maximum exposures are calculated for a wildfire occurring on the day of treatment.

Several assumptions were necessary due to missing or incomplete data. In all cases, these assumptions were made in a conservative manner (maximum reasonable risk was chosen over lesser risk) causing our estimates of risk to be high. This increases the margin of safety for workers and public.

Threshold limit values (TLV) published by the American Conference of Governmental Industrial Hygienists (1984) are used as an indicator of the lowest acceptable level of risk from herbicide residue in smoke. TLV values indicate an acceptable level of workers' daily exposure to airborne chemicals over their careers.

All herbicide/application-method brown-and-burn combinations evaluated are estimated to have significantly less risk than the TLVs allow. Seventy-four times less exposure than the TLV is the closest any typical herbicide/method combination came to the TLV. Even in the wildfire scenario (wildfire occurs the same day as application) the worst exposure projected is 46 times less than the TLV. Based on this comparison there is insignificant risk of negative health effects from brown-and-burn operations.

Bush and others (1987) measured residues released from burning herbicide-treated wood (in wood stoves or fireplaces). Herbicides evaluated were 2,4-D, 2,4-DP, dicamba, picloram, and triclopyr. Evaluation was made 4, 8, and 12 months after treatment. Residues under rapid combustion were generally much less than under slow combustion. They found that more than 95 percent of the tested herbicides were broken down by the heat of a well developed (800-1,000°C) fire. These concentrations are much less than the maximum exposure concentrations estimated for these herbicides in brown-and-burn operations (appendix A, table 5-24). Thus no significant potential exists for negative human health effects from the burning (in a hot fire) of firewood treated with these herbicides.

Bush and others (1987) also report that during slow combustion, relatively stable compounds such as 2,4-D, 2,4-DP, and dicamba were released in significant amounts. However, the levels reported were less than 1/1,000 of those judged to have acceptable risk when ingested on a daily basis.

3. Effects of Other Methods (General)

People are concerned about worker health and safety for all methods used in vegetation management.

Sources of Information

Although extensive accident reporting systems exist (U.S. Department of Health and Human Services, Office of Workman's

Compensation, and insurance companies), forestry-related activities cannot be isolated from data recorded in these systems. Additionally, national summaries of accidents (U.S. Department of Labor, Bureau of Labor Statistics and others) report only numbers of accidents. Therefore, data are taken directly from Southern Region accident reports. Three years of accident reports are analyzed. A total of 622 accidents involving field personnel requiring the care of a doctor were reported during fiscal years 1984, 1985, and 1986. Of the 622 field accidents regionwide, 123 are directly related to vegetation management. The 41 Coastal Plain-Piedmont accidents directly related to vegetation management are the basis for subsequent discussion.

Accident Frequency

Accidents have been reported from use of manual and prescribed burning methods. No accidents have been reported from mechanical or biological methods. The only reported herbicide related accident was a worker who slipped while carrying a backpack unit and twisted his ankle.

There were no vegetation management-related fatalities from any cause reported during the 3-year period studied. During the period 1976 - 1985 two tree felling deaths and two fire-related deaths were reported which were related to vegetation management.

No data exist to determine occurrence rates of other health problems. Such things as loss of hearing due to loud tools, cancers resulting from inhaling fumes from gasoline engines or gasoline contacting skin, and secondary infection of a wound from vegetation management are not reported in a way which allows analysis. All could occur, but frequency of occurrence is unknown.

Frequency of accidents by body part affected are presented in table IV-7. In table IV-8, frequency of accidents as a function of the activity being performed is displayed. Figure IV-1 shows the number of accidents expected during a 25-year career. Overall, traumatic injuries to the back, hand and skin predominate.

Based on tables IV-7 and IV-8, and figure IV-1, vegetation management activities rank as follows (most to least risky):

1. Range management
2. Prescribed burning
3. Road maintenance
4. Site preparation work
5. Trail maintenance
6. Wildlife habitat management

High risks include: a 2 in 10 chance of back injury to range management workers (an average of 1 accident for every

Table IV-7.—Body part affected: Average number of accidents per man year (40% field work) worked in several vegetation management activities in Coastal Plain-Piedmont forests; Region 8, FY'84-FY'86

	Site Prep	Pres Burn	Range	Wildlife	Road	Trail
Head, Neck, Ear, Nose	0.014					
Eye	0.005	0.009				
Skin	0.005	0.018			0.042	
Arm					0.008	
Wrist, Hand Finger	0.005	0.018		0.009	0.008	0.020
Back, Chest, Abdomen	0.002	0.018	0.104			
Legs	0.012	0.018				
Ankle, Foot, Toes	0.002					
Other						0.020
Total by Activity	0.045	0.081	0.104	0.009	0.059	0.039

Blank cells = no accidents reported during the three years being investigated.

Table IV-8.—Cause of injury: Average number of accidents per man year (40% field work) worked in several vegetation management activities in Coastal Plain forests; Region 8, FY'84-FY'86

	Site Prep	Pres Burn	Range	Wildlife	Road	Trail
Insects	0.004	0.009		0.009	0.033	
Fire		0.018				
Hand tools	0.007				0.008	0.020
Power tools Chain saw	0.012					0.020
Power tools Other						
Struck by Vegetation	0.012					
Slipping	0.002	0.009	0.035			
Lifting	0.002	0.027	0.069			
Dust & Debris						
Poisonous plants		0.009			0.017	
Other		0.009				
Total by Activity	0.045	0.081	0.104	0.009	0.059	0.039

Blank cells = no accidents reported during the three years being investigated.

Play It Safe. . .
Always Wear Safety
Equipment on the Job

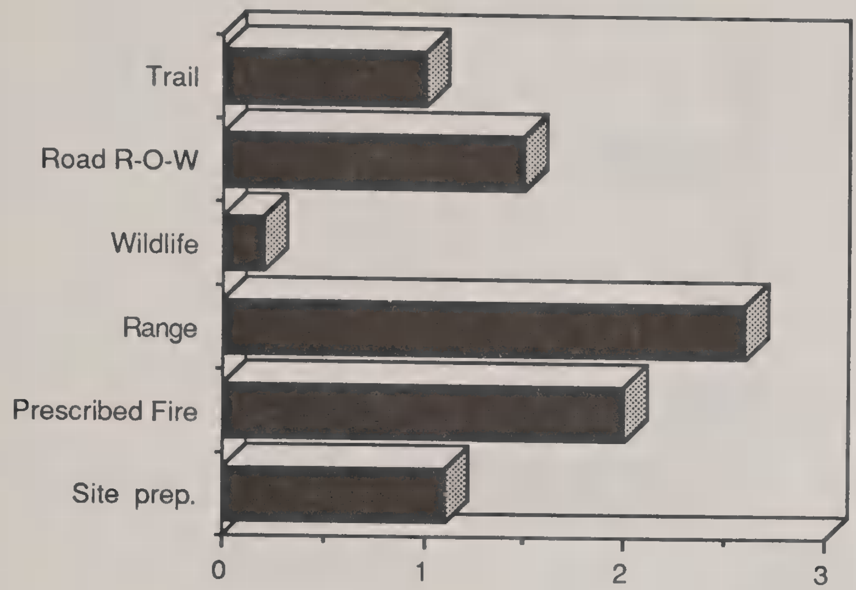


Figure IV-1.--Expected number of accidents per person during a 25-year (40% field work) career performing a single vegetation management activity on a Coastal Plain or Piedmont forest.

5 years spent doing this type of work); an approximately 1 in 10 chance of skin problems to full-time road maintenance workers; a 4 in 100 chance of wrist, hand, or finger injury for full-time workers doing either prescribed burning or trail maintenance (an average of 1 accident per 25 years of full time field work); and, the same risk (4 in 100) of back, chest or abdomen, leg, or skin injury for technicians doing prescribed burning.

Severity Rating

Severity rating is based on reported costs: low ($1 - $100), moderate ($100 - $500), and high (over $500). Severity of accidents related to site preparation is notable; 5 in 39 are in the severe category; 14 in 39 are moderately severe; and only slightly more than half are low severity accidents. Overall the ratios of low:moderate:severe accidents are similar between activities.

Table 5-28 of appendix A displays the risk of cancer or death resulting from several routine activities. Vegetation management activities contain more risk of accidental injury than these routine activities, though the consequences are normally less severe than death.

Figure IV-2 shows the average worker's risk of having an accident in a 25-year career. After correcting for the relative amounts of time spent in each activity, activities are rated (most to least risk): site preparation, prescribed burning, road maintenance, range habitat management, trail maintenance, and wildlife habitat management (figure IV-2).

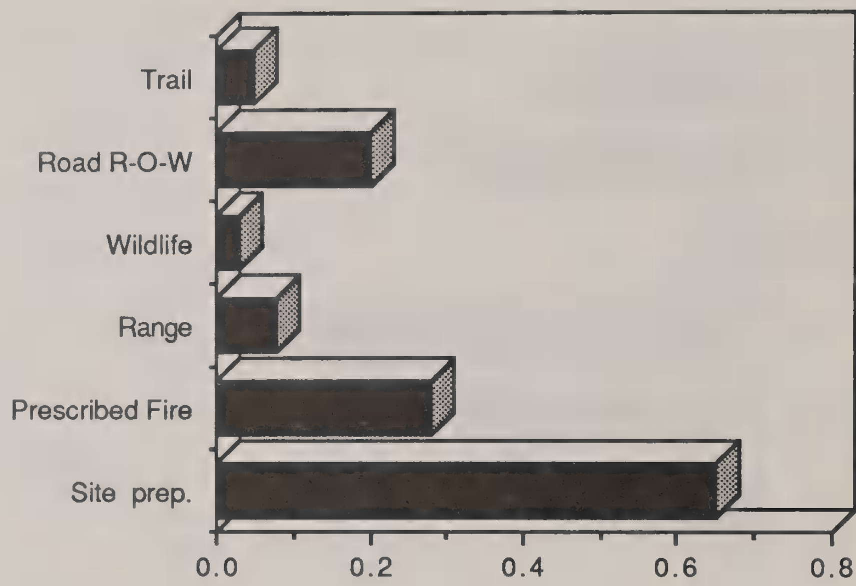


Figure IV-2.--Average number of accidents suffered by a worker working for 25 years (40% field work) in a vegetation management job with activity proportional to the average work program for Coastal Plain or Piedmont forests.

C. VEGETATION

1. Effects of Prescribed Fire

Prescribed fire can injure or kill vegetation. Whether or not a plant is injured or killed depends upon plant characteristics, fire type and behavior, wind speed, temperature, length of exposure, and season.

Injury and Mortality

Fire kills or damages plant leaves, needles, buds, stems, bark, branches, or roots. Extent of injury depends on species, age, diameter, height, and protective adaptations. Young, succulent, and actively growing vegetation is especially vulnerable (Hare 1961). For this reason, losses are generally greatest for seedlings or sprouts of any species.

Hardwood species are generally much less resistant to fire damage than are pine species (Wade 1983). Little mortality occurs once hardwoods are greater than 3 inches in diameter at breast height (d.b.h.) (Chen and others 1975; Goebel and others 1967); or 4 inches d.b.h. (Johnson 1982). Most pines are rarely killed once greater than 8 to 12 feet tall or more than 2 inches in groundline diameter (Cain 1985; Komarek 1974; Wade 1986).

Protective adaptations such as buried meristems, thick bark, protected buds, ability to resprout, and natural pruning of lower branches decrease the risk of plant injury or death (Gill 1981; Van Lear 1985). Wiregrass and curtis dropseed are herbaceous plants well adapted to fire; both have protected meristems about 1.5 inches below ground

(Lemon 1949). Tree bark provides protection from fire temperatures. Species which have thicker bark are much less susceptible to fire damage (Hodgkins 1958; Langdon 1971; Wade 1986). When little damage is done to the buds of pines they can survive even severe needle loss (Wade and Johansen 1986a, 1986b). In addition, natural pruning of lower branches by many pine species prevents low to moderate intensity prescribed fire from reaching tree crowns. The ability to resprout when the above-ground portion of the plant is killed is another important adaptation. Although pines are more resistant than hardwoods to damage from fire, if pines are top-killed (when the entire above-ground portion of the plant is killed back) they do not readily resprout. Hardwoods can resprout, but this ability decreases with age and size.

Fire type and behavior also determine whether plants are injured or killed. Three types of fire occur. Crown fires consume the tops of trees, and they are very intense and kill most vegetation. Surface fires consume woody shrubs, vines, and herbaceous vegetation. The intensity of surface fires depends upon the amount and type of fuel present as well as weather conditions. Ground fires burn below the surface and kill the roots of plants. Surface fires are the fires manipulated for prescribed burning. Intense surface fire in areas with large amounts of available fuel create a high risk of injury or death to vegetation. According to Langdon (1981), backing fires develop fireline intensities to 60 Btu/ft/sec, while flanking and strip-head fires develop fireline intensities from 60 to 160 Btu/ft/sec. He also noted that at an intensity of 600 Btu/ft/sec, surface fires are not generally controllable and may move into the crown fire category.

Temperature, length of exposure, and season significantly affect plant survival. According to Hare (1961) plant tissues are instantly killed at 140°F. Also, plants can be killed at somewhat lower temperatures when exposed for long periods, and the temperature the plant is exposed to depends on distance from the flames and fire intensity (Hare 1961; Wade and Johansen 1986a).

Growing-season fires injure or kill more vegetation than dormant season fires. In one study by Hodgkins (1958), burns conducted during August (growing season) killed 97 percent of 1-inch d.b.h. pines, and 60 percent of 2- and 3-inch d.b.h. pines. Burns conducted during January (dormant season) killed 41 percent of 1-inch d.b.h. pines, and no 2- or 3-inch d.b.h. pines. Wade (personal communication) found that, during the transition period between growing and dormant seasons, burns that scorch 100 percent of needles pose significant risks of mortality of slash pine only.

Hodgkins (1958) found that August burns top-killed 62 percent of 1-inch d.b.h. hardwoods, 52 percent of 2-inch d.b.h. hardwoods, and 38 percent of 3-inch d.b.h. hardwoods; while in January 46 percent of 1-inch d.b.h. hardwoods, 5 percent of 2-inch d.b.h. hardwoods, and no 3-inch d.b.h. hardwoods were top-killed. Within 2-1/2 years dense new hardwood growth replaced the top-killed individuals on all burn plots. Lotti and others (1960) determined that dormant season fires did not kill rootstocks of hardwoods; top-killing occurred but the hardwoods resprouted. They found that growing season fires not only top-killed stems but also killed the roots of many hardwoods. Brender and Cooper (1968) also determined that greater mortality resulted from growing season fires. Chen and others (1975) found no significant difference in mortality, however, between growing- and dormant-season burns. They determined that growing-season burns reduced vigor of resprouting hardwoods.

Some of these responses may be due to seasonal temperature differences. Dormant season air temperatures are generally low and more fire heat is needed to reach the lethal 140°F mark than during the growing season when ambient air temperature is quite high (Wade 1983; Wade and Johansen 1986b; Fennell and Hutnik 1970).

Some external indicators of injury to plants from fire include color changes in needles or leaves, bark scorch, and possibly pitch flow (Hare 1961). Mortality cannot be easily determined immediately following a fire. Injuries may only set back or weaken plants. Accurate losses from severe fire may not become apparent for several years.

Prescribed fire can cause less immediate effects than obvious plant injury or mortality. These latent effects include changes in susceptibility to insects and disease, reproduction, nutrient content, and growth response.

Plant Susceptibility

Fire can increase or decrease plant susceptibility to damage from insects and disease. Wounds such as fire scars increase susceptibility by weakening plants and providing entry points for insects and disease. Fire decreases disease susceptibility by reducing or controlling brownspot needle blight of longleaf pine grass stage seedlings (Maple 1977), annosus root rot of loblolly and slash pine (Froelich and others 1978), and fusiform rust of loblolly and slash pine (Lotan and others 1981; Hare 1961). The quality of oak sprouts may be improved through the use of prescribed fire by producing sprouts that originate lower on stumps; this may provide more decay resistant sprouts (Augspurger and others 1986).

Reproductive Success

Success of reproductive functions such as germination, flowering, fruiting, and seed production are affected by fire. Cushwa, Martin, and Miller (1968) observed that, during simulated fire conditions, moist heat significantly increased the germination of some species of legume seed. Fire may cause the seed in the soil to break dormancy, but can reduce germination and destroy seeds when lethal plant temperatures are reached. Garren (1943) in reviewing some of the early work of Chapman reported a great increase in germination of longleaf pine seed where prescribed burns were implemented just before seedfall occurred. In general, germination success is directly enhanced by the reduction of competition for light and nutrients and by seedbed preparation that exposes some mineral soil. Fire also initiates the opening of cones of serotinous pines (Langdon 1981).

Wiregrass has produced new leaves three days after a fire in response to early growing season burns; and in the fall following a May burn it tends to seed profusely (Lewis 1964). Early growing season burns in an Eaton and White (1960) study increased the number of sprouts and buds of lowbush blueberries. Johnson and Landers (1978) found negligible fruit production during the first post-burn growing season in slash pine stands 16 to 30 years old that were underburned during the dormant season. During the second growing season fruit production increased with some species such as dwarf huckleberry and runner oak attaining peak production. Three growing seasons after dormant season underburning, fruit production peaked. Stransky and Halls (1979a) found that dormant season burns produced an increase in the fruit yield of dogwood but in general produced a mixed response of fruit yields of woody plants.

Nutrient Content Nutrient content of some forage species are increased by prescribed burning. Campbell and others (1954) found both protein and phosphorus are increased until May by late dormant season burns.

Growth Response Prescribed fire can change the environment in which plants grow. They remove litter from the ground surface, and temporarily reduce other woody or herbaceous species that compete for growing space, moisture, nutrients, and light required for optimal success in germination and establishment. Komarek (1974) noted that in the pine-wiregrass community, pitcher plants and various orchids are adapted to frequent fire and are unable to compete with litter accumulations or competition from woody species for light and nutrients.

Growth responses from burning have been both positive and negative. Early growing season burns improve height growth of longleaf pine seedlings (Grelan 1975, 1983; Maple 1977). However, in young longleaf pine saplings, Boyer (1985, 1987) found that biennial dormant or growing season burns of varying fire intensity produced from backfires, flanking fires, and strip-head fires, all reduced young longleaf pine height, diameter, basal area, and volume.

Depending upon fuel load and weather variables, low to moderate intensity fire can be expected to result in low to moderate amounts of crown scorch. Minor amounts of crown scorch, approximately 0-15 percent, were found by Johansen (1975) to enhance the growth of young slash pine. He also concluded that needle scorch of less than 40 percent of crowns did not reduce growth. Lilieholm and Hu (1987) working with loblolly pine also found that light amounts of scorch may increase growth. Waldrop and Van Lear (1984) found that moderate crown scorch did not affect the growth of unthinned young loblolly pine trees of dominant or codominant crown classes. Complete crown scorch caused 20 percent mortality of codominant and 30 percent mortality of intermediate crown classes. High amounts of scorch can be expected to produce decreases in diameter and height growth of loblolly and slash pine (Cain 1985). In a study by Johansen and Wade (1987) slash pine with extreme amounts of crown scorch suffered no mortality during the first postfire growing season but severely scorched trees averaged 60 percent growth loss two seasons later. Slightly scorched trees averaged a 15 percent growth loss.

Community structure can be altered by temporary changes in canopy position and species composition. More long-term effects from prescribed fire occur as successional changes resulting from the interaction of species composition with fire intensity, frequency, and season over time.

Canopy Position

Lay (1967) noted that effects on understory vegetation is dependent on characteristics of understory prior to treatment. When fire is used in an understory of low-growing woody species, the amount of browse is reduced temporarily, but the quality of browse is improved. When fire is used in higher understory, canopy position is lowered as tops are killed back, but resprouting is rapid, and ultimately more browse becomes available. Chen and others (1975) determined that winter and summer burns reduced canopy height of woody species by more than 6 feet, and summer burns additionally reduced vigor of resprouting hardwoods.

Species Composition

Species composition changes occur with increased fire intensity and frequency. Season of burn is also an important variable. More intense fire causes greater shifts in species composition by reducing small woody species and increasing quantities and types of herbaceous vegetation through the preparation of seedbeds more favorable to herbaceous species (Van Lear and Johnson 1983). As intensity increases, legumes and other forbs and grasses are especially favored (Cushwa and Redd 1966; Cushwa, Brender, and Cooper 1966; Czuhai and Cushwa 1968).

Single burns that occur once per stand rotation, especially of low to moderate intensity, do not significantly change species composition. One winter (dormant season) or summer (growing season) burn initially reduces hardwood vegetation, but it recovers to previous levels in 5 to 7 years (Langdon 1971). Wade and Wilhite (1980) noted woody species recovery to nearly preburn levels by 6 years. Martin and others (1979) and Huntley and McGee (1983) also concluded that burning initially reduces woody species coverage, but woody species composition is not significantly changed.

One winter burn was found by Moore, Swindel and Terry (1982a) to reduce woody species coverage, increase herbaceous species frequency and biomass, and encourage a greater variety of understory species. Prior to burning they encountered 30 woody and 37 herbaceous species, but after burning they encountered 32 woody and 61 herbaceous species. Decreases in saw palmetto and gallberry and increases in dwarf huckleberry and runner oak were also encountered.

Harlow and Bielling (1961) recommend burning cycles for specific objectives; a 3-year cycle to produce high amounts of forbs and legumes, 4 to 6 years for best understory hardwood growth and mast production, and annual burns for the greatest variety and number of plant species. Johnson and Landers (1978) recommended a 3-year burning cycle for the production of fruiting plant species for wildlife.

Frequency and season of burn combine to create significant impact on species composition. Frequent prescribed burns reduce woody species and increase herbaceous species (Lewis and Harshburger 1976). Frequent burns result in less vigorous sprouts and fewer sprouts as more rootstocks are killed with each successive fire (Johnson 1982, Chen and others 1975, Grano, 1970, Trousdell 1979). Lotti and others(1960) determined that woody species control was minimal with annual winter burns because the rootstocks of most species survived, and once annual burns were discontinued woody species regained dominance. Van Lear and Johnson (1983) also noted that annual winter burns do not reduce the number of hardwood sprouts but only affect the size of sprouts, whereas annual summer burns effectively eliminated small woody stems. Frequent prescribed burns can effectively prevent seedling establishment of woody species. Dormant season burns are not effective in killing the roots of woody species, but frequent growing season burns are, and result in greater changes in species composition.

Successional Patterns

Prescribed fire can set back succession to early seral stages dominated by herbaceous species. Intensity, frequency, and season determine to what extent succession is affected. Long-term use of fire at frequent intervals, especially during the growing season, restricts the development of woody species and promotes herbaceous species.

The fire succession pattern described by Hare (1961) is dominated first by forbs, then perennial grasses, and ultimately perennial woody species. How far succession is set back by a given fire depends on initial stand composition, fire intensity, available seed sources, and prefire and postfire weather variables (Fennell and Hutnik 1970).

The successional pattern for southern pine forests is a gradual replacement of pines by invading hardwoods. Understory burns in southern pine forests retards this successional pattern (Pyne 1984). On grasslands the use of fire favors grasses and retards woody species encroachment.

Lewis and Harshburger (1976) reported the effects of 20 years of prescribed burning in South Carolina flatwoods. Their study looked at seasonal and frequency impacts on woody and herbaceous vegetation from annual, biennial, and periodic dormant and growing season burns. They concluded that after 20 years of burning the understory had been significantly altered. Annual summer (growing season) burns eliminated almost all shrubs, had the highest number of herbaceous species (29), and grasses became the dominant herbaceous species. Annual winter (dormant season) burns resulted in numerous low-growing shrubs, had the next

highest number of herbaceous species (26), and significantly increased the coverage of lespedeza, blackberry and sumac, but reduced gallberry, southern wax myrtle, and yellow jessamine. Biennial summer (growing season) burns were similar to annual summer burns in that most shrubs were reduced, it had the third highest number of herbaceous species (24), and of the woody species, greenbrier and sweetgum were significantly reduced while sumac was significantly increased. Both types of periodic burns occurred when 25 percent of hardwood stems reached 2 inches in diameter. Periodic summer (growing season) burns created site conditions dominated by low-growing shrubs, had an intermediate number of herbaceous species (22), and southern wax myrtle significantly increased while greenbrier significantly decreased. Periodic winter (dormant season) burns also left sites dominated by low-growing shrubs, had the second lowest number of herbaceous species (18), and sweetgum and grape significantly increased while greenbrier significantly decreased. The control area was not burned, and was dominated by low-growing shrubs. It also had the lowest number of different herbaceous species (11).

2. Effects of Mechanical

Mechanical methods can injure or kill vegetation. Mechanical tools, in increasing order of intensity, are: mowing, chopping, shearing, scarifying, ripping, piling, raking, disking, and bedding.

Injury and Mortality

Shearing and mowing tools cut only the above ground portions of plants. They effectively kill species, such as most pines, that do not have the capacity to resprout. Piling tools are normally used after stems have been sheared or manually cut. Mortality is low as long as plants are not uprooted.

Chopping cuts above ground stems, but also severs plant roots or rhizomes (horizontal stems below ground). Research has shown that high mortality from double chopping occurs to wiregrass, saw-palmetto, runner oak, ground blueberries, and dwarf huckleberry (Lewis, Tanner, and Terry review draft; Lewis 1980a, 1972; Moore, 1974; Yarlett 1965). Gallberry, due to its ability to resprout, is only injured and quickly recovers, while blackberry and wax myrtle stems increase with chopping (Lewis, Tanner, and Terry review draft).

Significantly higher injury and mortality occur with more intensive raking, disking, bedding, ripping, and scarifying tools because more rootstocks are affected. Schultz (1976) found that disking or bedding treatments significantly reduced saw-palmetto, gallberry, and curtis dropseed and that gallberry rapidly sprouts back from buried stems and roots.

Mechanical methods effectively reduce or control woody and herbaceous competition, permitting increased survival and growth of planted pines and hardwoods.

Competition

Edwards (1986) observed that more intensive treatments were more effective in reducing competition, producing greater seedling survival after the first growing season and the best height growth responses at the end of two growing seasons. Slay and others (1987) did not find significant differences in survival; all treatments produced acceptable survival. They did, however, note the relationship between amount of competing vegetation reduction and seedling growth response. Treatments that are combinations of tools are generally more effective in competition control. Stransky and Halls (1981) compared burning, chopping and burning, and a treatment consisting of shearing, raking, burning, and disking. The latter, which is the most intensive, provided the greatest amount of competition control and produced significantly greater tree growth than the other two treatments. Chopping and burning produced the next highest response, followed by the burning only treatment.

Growth Response

Outcalt and Brendemuehl (1984) found that chopping significantly increased diameter growth, and, to a lesser extent, also increased height growth of sand pine.

In one study, ripping caused no effect on first or second year survival of loblolly pine, but provided increased soil moisture in the upper 4 inches of soil. By the end of two growing seasons, ripping increased total seedling height by 10 percent (Wittwer and others 1986).

Stafford and others (1984) showed significant loblolly survival, height, and diameter growth responses with shearing, raking, or disking treatments. In their study all disking treatments increased early growth from what they attributed to relieving compacted soil conditions.

Disking has also improved survival and growth of planted hardwoods. Kennedy (1981a,b) compared mowing and disking treatments with a no treatment control plot for sycamore, green ash, nutall oak, sweet pecan, cottonwood, and sweetgum. He found that disking provided hardwoods with additional water and nutrients by controlling vines and weeds. Seifort and others (1984) compared disking, disking and bedding, and no treatment for planted swamp chestnut oak. Survival did not differ between the two methods, but survival with no treatment was 15 percent lower than either method. Disking has also doubled the amount of survival, and increased height growth of cherrybark oak by 18 percent (Woodrum 1983).

Outcalt (1983) found that disking increased slash pine diameter, height, and volume growth. Studies by Tiarks (1982), and Mann and Derr (1970) have shown similar positive growth responses for loblolly and slash pine.

Bedding tends to produce even more dramatic growth responses than disking. Dewitt and Terry (1982) documented significant loblolly growth response to shearing, piling, and bedding treatments. Bedding was especially effective in reducing competition by cutting and exposing the roots of woody species. In Pritchett's (1979) study, bedding resulted in a four foot height growth advantage over a burn only treatment, while disking produced a one-foot height advantage over the burn only treatment. Survival on bedded sites was three times better than those which were burned only, which Pritchett felt was due to greater competition control. Mann and Derr (1970), McKee and Wilhite (1986), Gent and others (1986), and Baker (1973) also documented increased growth responses from bedding on loblolly and slash pine. However, Derr and Mann (1977) noted increased seedling mortality on bedded sites when planting occurs before bed settling, and they also encountered an increased incidence of fusiform rust on bedded plots.

Growth losses can occur from piling and raking treatments when nutrient displacement occurs. Swindel and others (1986) found that tree height, basal area, and volume were smaller for trees not growing near or adjacent to windrows. They attributed this to the accumulation of soil and litter in the windrows.

Lennartz and McMinn (1973) reported on the effect of low (burn only) to high (complete clearing) intensity site preparation treatments on slash pine height growth. Responses to mechanical treatments, though declining over time, were still significant 10 years after the initial treatment. However, several studies have shown that by 13 to 15 years the advantages provided by low to high intensity mechanical treatments are no longer significant for pine diameter, height, or volume growth (Tiarks 1982; Haywood 1980, 1983; Outcalt 1984; Buford and McKee 1987).

Species Composition

Shifts in species composition are caused by use of mechanical methods. Mechanical treatments reduce woody species and increase herbaceous species temporarily. In general, the more intensive a treatment is the greater the shift in species composition. Lewis, Tanner, and Terry (review draft) noted that mechanical methods reduced woody species coverage but that overall species composition was not affected. Miller (1980) also determined that while tree, shrub, and vine species were 55 percent smaller on windrowed areas compared to chopped areas, there were no differences in overall species composition. Both areas had approximately 118 herbaceous and 15 grass species.

In comparing burning and disking treatments Buckner and Landers (1979) determined that herbaceous annuals and perennials are favored by disking. After one growing season single disked areas had better herbaceous growth and production than double disked areas, but during the second year the double disked areas yielded more herbaceous food plants and seed than even annually burned plots.

Successional Patterns

More long-term effects from mechanical methods are successional changes over time. Mechanical treatments can set back succession to early seral stages dominated by herbaceous species and provide early growth advantages to desired pine and hardwood species. Succession is set back further by the more intensive mechanical methods and recovery of these areas is slower. Depending on intensity, woody species recovery occurs 5 to 10 years following treatment.

Research has shown that following harvest and site preparation by low to high intensity mechanical methods, herbaceous species temporarily increase while woody species temporarily decrease. One study by Conde, Swindel and Smith (1983a) showed that by the second year after harvest and site preparation by chopping and bedding, herbaceous species dominated the site but woody species were beginning to recover. Their conclusions were based on measurements of woody and herbaceous species cover, frequency, and biomass. A more intensive mechanical treatment consisting of prescribed burning, shearing, piling, disking, and bedding,

produced similar results but succession was set back further (Conde, Swindel and Smith 1983b). Woody species recovery was slower but after 2 years it was beginning to increase. After 5 years the lower intensity treatment area (chopping, bedding) was again dominated by woody species while succession on the higher intensity treatment area (burning, shearing, piling, disking, bedding) was proceeding towards a woody species community but was still dominated by herbaceous species.

Vegetation impacts from burning, chopping, shearing, and raking were analyzed by Stransky and others (1986). They found that 1 year after mechanical site preparation herbaceous species increased and woody species declined, with less decline on chopped than sheared and raked areas. After 3 years the herbaceous species peaked and woody species were almost back to pretreatment levels. During the 5- to 10-year period after treatment, herbaceous species declined as they were shaded out by the pine and hardwood canopy closure. Ten years after the treatments, the woody species had fully recovered.

Mechanical treatments are more effective than other methods, such as fire, in reducing woody species (Stransky and others 1986; Moore, Swindel, and Terry 1982b) and mechanically treated areas are slower to recover to pretreatment levels than other methods (Lewis, Tanner, and Terry review draft).

3. Effects of Herbicides

Herbicides injure or kill plants. The effect of a specific herbicidal treatment, however, is the result of many interacting factors including: the initial vegetation onsite; selectivity of the herbicide and application method used; pattern in which the herbicide is applied; biochemical effects of the herbicide on vegetation; and timing of the treatment. General discussion of the vegetation effects is found below; further discussion of the tools and herbicides is found in chapter II.

Herbicides can be broadcast or more selectively applied. Broadcast application achieves uniform distribution of herbicide. Aerial and ground-mechanical application of granular or liquid products are generally broadcast. Broadcast application is commonly used for site preparation, release, and rights-of-way maintenance. Selective methods allow for incomplete coverage or application to specific targets. Hand applications are generally target or spot specific. Directed foliar sprays, cut-surface treatments, and basal stem treatments are target selective; spot around and basal soil spot treatments are less so; grid soil-spot, banded foliar, and many herbaceous weed treatments are the least target specific of the selective methods. More selective application patterns have less risk of affecting

non-target vegetation than do broadcast applications. They are commonly used for release, precommercial thinning, and wildlife habitat improvement.

Rates of uptake and time until the first effects show vary with species and product. Dicamba, fosamine, 2,4-D and 2,4-DP are taken in through leaf, stem and root tissue. Imazapyr enters either through the roots or leaves. Hexazinone and tebuthiuron are taken in primarily through the roots with some entering through leaves. Picloram and sulfometuron methyl primarily enter through the leaves, but there is some root uptake. Glyphosate and triclopyr enter primarily through leaves.

Some plant surfaces are designed to selectively protect the plant (bark on stems, wax on leaves). Penetration of these surfaces is enhanced by using additives such as diesel oil, kerosene or limonene. Thickness of bark or wax influence the effectiveness of a herbicide treatment even when an additive is used.

Modes of Action

Once a herbicide is taken into a plant, it may move through plant tissues. Many herbicides concentrate in growing tissues and disrupt normal functioning. Some disrupt photosynthesis (glyphosate, hexazinone, and tebuthiuron), some interfere with amino acid synthesis (imazapyr), and others (dicamba, fosamine, picloram, sulfometuron methyl, triclopyr, 2,4-D, and 2,4-DP) interfere with growth processes such as cell enlargement, cell reproduction, or bud formation and enlargement.

Translocation of chemicals in the plant generally follows the normal food movement system. Dicamba, glyphosate, picloram, and triclopyr are translocated up and down in plants, accumulate in plant roots or root collars, and effectively suppress sprouting from stumps. Fosamine inhibits bud formation and growth, and is practically immobile; thus it can be used to chemically prune only a part of a plant.

Some herbicides are broken down by plants. Limited information is available about the chemical breakdown products and their effects.

Between Species Variation in Response

Effectiveness of herbicides varies among plant species. Dicamba, 2,4-D, 2,4-DP, picloram, fosamine, and triclopyr are used to control woody species and broadleaf weeds. Glyphosate, hexazinone, imazapyr, and tebuthiuron are effective against grasses, woody species, and broadleaf weeds. Sulfometuron methyl is used primarily to control weeds and grasses. Glyphosate, hexazinone and imazapyr applied at low rates also selectively control weeds and grasses.

Some herbicides are essentially ineffective against certain plants. Though effective against most hardwood species, hexazinone has virtually no effect against yellow-poplar. Imazapyr gives little or no control of locust, redbud, blackberry, and most legumes.

Some plants or groups of plants are extremely difficult to control. Glyphosate is fairly effective against sedges; picloram and dicamba are commonly used to control kudzu. Tebuthiuron is also used for kudzu control on non-forest sites (Miller 1986).

Effects of herbicides also depend on season. Fosamine, which blocks spring bud break, is a very slow acting, fall-applied herbicide; effects are usually not seen until the next spring. Glyphosate, which functions best when target plants are flowering, is also most effective in the fall. Spring or early summer applications of dicamba, 2,4-D, 2,4-DP, hexazinone, and tebuthiuron are best, while spring, summer or fall (excluding droughty periods) are acceptable for picloram, sulfometuron methyl, or triclopyr. Cut surface treatments are made throughout the year.

Several herbicides are soil active; once in the soil they can be taken up by plants. Hexazinone, imazapyr, and tebuthiuron are soil active. Dicamba, picloram, sulfometuron methyl, triclopyr, 2,4-D, and 2,4-DP have some soil activity. Non-target plants may be affected if they are within the treated area or if their roots grow into it. Hexazinone remains active in the soil for 2 weeks to 6

months; imazapyr and tebuthiuron reamin active longer. Spike[R] (tebuthiuron) labels carry the warning that the product is "...a very active herbicide which will kill trees, shrubs and other forms of desirable vegetation having roots extending into the treated area." (Elanco 1986). This effect persists significantly longer than a growing season in the South and can last for five years in arid climates.

Herbicides evaluated do not appear to affect seed biochemistry or germination rates. Soil active herbicides do, however, affect young seedlings emerging from seeds in treated areas. Persistent soil-active herbicides can cause a temporary shift in types of vegetation growing on a site.

Succession

One objective of vegetation management is to disrupt succession. However, there is no evidence that repeated typical applications of a herbicide causes permanent effects on succession. Normal succession resumes within one to three years of last application of herbicide (Bramble and Byrnes 1982).

Information about additional effects of herbicide use in an environment already affected by industrial pollution, agricultural pesticide usage, and automobile emissions is unavailable. Herbicides are applied to individual stands only one to three times during the 60 or more years they are grown. Herbicide use rates in forestry applications are also very low relative to agricultural or other uses. Application of herbicides on rights-of-way is more frequent than in forest management, and the objective is to hold vegetation in corridors in early successional stages. Even with more frequent treatments, normal successiom resumes after treatment is discontinued.

4. Effects of Biological

Cattle grazing can injure or kill vegetation. Grazing also causes changes in plant growth response, and shifts in species composition.

Injury and Mortality

Cattle consume pine and hardwood foliage, and young new shoot and twig growth. Amounts consumed are minor since herbaceous species comprise the bulk of their diet. Plant mortality from direct consumption is low because rootstocks are normally not affected, and most woody and herbaceous species resprout.

Damage to pine and hardwood seedlings occurs from browsing and trampling. In sapling and larger-sized stands, damage occurs from the browsing of lower branches, and by the breaking of lower branches by leaning or rubbing (Lewis, Tanner, and Terry review draft).

Lewis (1980b) simulated cattle injury to planted slash pine and found most mortality occurs 1 to 2 months after an

injury. Pearson and others (1971) found that 80 percent of plant mortality occurs a few months after planting, and once herbaceous species are available cattle stop browsing pines. Most planting occurs during the dormant season (December through March) when most herbaceous forage species are unavailable to cattle. The greatest mortality of planted seedlings occurs on heavily grazed sites; light to moderate grazing seedling losses are not significant (Grelen and others 1985; Pearson and others 1971; Clary 1979). Considering that heavy grazing is required to achieve biological vegetation control objectives, significant losses from injury and mortality are expected.

Growth Response

Effects on growth responses are mixed. Pearson and others (1971) found no significant impact from grazing on growth of seeded or planted pine through 5 years of age. However, measurements taken by Grelen and others (1985) on the same site at age 18 showed significantly larger tree diameters on heavily grazed plots compared to ungrazed control plots. Height growth and volume were not affected. Herbaceous forage yields monitored over a 10-year period were not significantly impacted by heavy utilization intensities as high as 60 percent of the current year's growth (Pearson and Whitaker 1974a, 74b; Clary 1979).

Species Composition

Shifts in species composition occur from heavy grazing. Herbaceous species which comprise the majority of preferred cattle feed are most affected. Grazing can increase forbs and decrease grasses. As grazing intensity increases, species such as pinehill bluestem and panicums decrease and carpetgrass increases (Clary 1979; Pearson and Whitaker 1974a). Woody browse species do not appear to be significantly affected (Pearson and Whitaker 1974b; Clary 1979).

Heavy grazing intensities utilized to achieve site preparation or release objectives when used for more than one or two consecutive growing seasons will change species composition. The longer areas are intentionally overgrazed, the higher the risk of long-term shifts in species composition.

5. Effects of Manual

Injury and Mortality

Manual methods can injure or kill vegetation by completely severing or girdling woody stems. Plants such as most hardwood species and woody shrubs that resprout are usually injured. Plants, such as most pine species, that do not resprout are usually killed. Non-target vegetation can also be injured or killed when woody shrubs or trees being felled fall onto or cover other stems. Loss of stems selected to remain can be significant. Bernstein (1981) found that 31 percent of conifers in a release project were damaged or covered by slash. A significant risk of injury and mortality in young pine or hardwood plantations exists

from the buildup of hazardous fuels from manual release and precommercial thinning projects. This risk is highest for precommercially thinned stands approximately 1 to 6 months after project completion.

Wounds caused by felling woody shrubs or trees onto remaining stems create entry points for insects and disease organisms which may eventually cause stem mortality. Miller and Phillips (1984) observed that stumps from chainsaw treatments for hardwood site preparation produce sprouts with higher risk of decay and poor anchorage than mechanically sheared stumps, because the sprouts originate higher on the stumps and closer to cut surfaces.

Incomplete severing or girdling of target vegetation may not cause immediate mortality but weaken individual stems and cause mortality several seasons later. A study by Cody (1976) showed that a single chain saw girdle was effective in removing unwanted hardwood vegetation (90 percent mortality), but mortality occurred over four growing seasons.

Growth Response

Species which resprout can quickly reoccupy treatment sites, and height growth of sprouts can exceed that of natural and planted seedlings (Miller and Phillips 1984). On moderate to highly productive sites several repeated treatments may be needed to successfully release desired species.

Long-term effects of manual methods on vegetation are negligible. Sprout growth and crown closure rapidly reoccupy the site.

D. WILDLIFE & AQUATIC ANIMALS

The effects of vegetation management on animals can include physical injury or mortality, and short-term and long-term habitat alteration.

Injury and Mortality

Death may result from the toxic effects of herbicides, effects of prescribed fire, or from mechanical, manual, or biological treatments applied to a site when animals are present.

Habitat Alteration

Wildlife habitat is the food, water, and cover that an animal needs to survive. Each species is adapted to a unique arrangement of these elements referred to as a niche. The distribution of different ecological types and progression of successional stages through time provides these niches. As habitat changes, so does the variety and abundance of wildlife species.

Vegetation management affects each species' habitat in a different way, benefiting some and harming others. For instance, when natural succession is retarded, species which need early successional stages usually benefit. Vegetation

management also affects wildlife when it influences a key habitat element such as food or a place to breed. For example, site preparation may increase or reduce the number of snag trees available for cavity nesting birds. Or the numbers of soft-mast producing plants may be reduced by the application of herbicides or increased by a mechanical method which encourages sprouting, such as chopping.

The structural diversity of vegetation is probably the most important factor in determining wildlife species composition and abundance (Harris and others 1979). Prescribed underburns, for example, alter vegetation structure and composition by reducing woody understories and increasing ground vegetation. This action benefits species such as white-tailed deer by providing more desirable food sources but may hurt songbirds like hooded warblers (Wilsonia citrina) which use the woody understory.

To keep the effects of vegetation management in perspective, it should be stressed that most vegetation management occurs after habitat has already been substantially altered by timber harvest or regeneration. Silvicultural system (even-aged, all-aged); intermediate thinnings or final harvest; distribution, size, and shape of regeneration areas; rotation age; streamside management zones; retention of old-growth; erosion control; road construction; and other management practices prescribed in Forest Land and Resource Management Plans (and outside the scope of this document) are likely to have a greater impact on wildlife abundance and species composition. Harvest of a mature pine stand, for example, tends to have a more significant effect on wildlife species occupying the site than subsequent site preparation or intermediate treatments which interrupt or accelerate the process of succession.

When vegetation management practices in combination with timber harvest and other management practices are applied in a forest, a variety of vegetation types and structure results. Over time, a mosaic of niches is spread across the forest landscape and habitat is provided for many different species of animals. This cumulative effect increases over-all or "among-stand" wildlife diversity even though "within-stand" diversity for a particular site may decrease.

Many treatments (pine release by herbicide, for example) are applied only once to a site. More long-term effects occur when more than one treatment (such as chainsaw, stump-spray, and prescribed burn) is applied to the same site. Since this normally occurs only once in the life of the stand, long-term impacts are not as likely as when stands are treated repeatedly. An example of multiple and repeated treatments is site preparation by KG blade, windrow, and prescribed burn followed by herbicide release at age 3, and prescribed burning on a 5-year cycle beginning at age 10. This sort of periodic treatment is effective in relegating many hardwoods to the understory. Although many hardwoods survive, many important species do not reach the age or size necessary for mast production or creation of nest cavities. In addition, periodic burning tends to remove downed woody material which provides habitat for reptiles and amphibians and eliminates accumulations of tops and brush which are used for cover by species like cottontail rabbits (Sylvilagus floridanus). However, burns also provide a continuing source of new den sites, downed vegetation, and brushpiles when living trees are killed by fire.

More research is needed into long-term effects on animals associated with plant communities treated with specific combinations of herbicides and periodic fire. Ongoing research and vegetation classification and inventories planned for the Southern Region will help fill some of these gaps.

1. Effects of Herbicides

Source of Information

Information sources for assessing the risk of direct toxic effects to wildlife and aquatic animals are the same as for the human health risk assessment discussed in section B of this chapter. Three sections of the risk assessment apply to the analysis of risk to wildlife and aquatic species.

Section 6 (the hazard analysis) documents basic toxic properties of the chemicals.

Section 7 (the exposure analysis) documents probable exposures to these chemicals of terrestrial animals such as mammals, birds, reptiles, and invertebrates; and aquatic animals such as fish, invertebrates and amphibians.

Section 8 (the risk assessment) combines predicted hazards and exposures, and estimates danger to these animals.

Hazard Identification

Hazard is evaluated based on dose/time relationships. These relationships and their effects are the same as for human health: acute toxicity, subchronic toxicity, chronic toxicity, mortality, and organ effects.

Exposure and Dose Response

Exposure considerations include where the animal lives, how it moves and feeds, external characteristics of the animal (hair, feathers, scales), rate of herbicide application, size of treatment area, the way the herbicide was applied, and physical characteristics of the herbicide (persistence or drift potential). Exposure is estimated for three different situations:

> The **typical** situation (the "realistic" scenarios in the risk assessment) estimates the average exposure of terrestrial and aquatic animals that may be reasonably expected during routine operations.
>
> The **maximum** situation ("extreme" scenarios in the risk assessment) estimates the worst realistic exposures to terrestrial and aquatic animals when highest rates of herbicide are applied in an area.
>
> An **accident** situation estimates the exposure of terrestrial and aquatic animals which might result from direct exposure to herbicide resulting from a spill of cans from a truck or a helicopter tank dump into water.

Risk is a function of dose, which is critically dependent on many interrelated factors. Changing any of the factors modeled when predicting risk will change the dose and the potential effects on animal health. Estimates were also made of indirect exposures due to surface, subsurface, or airborne movement of the herbicides and additives in the environment.

Exposure Information

Because toxicological data is unavailable for most species occurring in the Coastal Plain/Piedmont, a set of species were chosen to represent animals from a variety of habitats and dietary needs. Terrestrial mammals, birds, amphibians, reptiles, and invertebrates, and fish and aquatic invertebrates were selected. Since laboratory tests are not normally done on wildlife species, it was necessary to evaluate several of the representative species by using data for similar animals for which tests have been done.

<u>Terrestrial species</u>: Herbicide skin contact, inhalation (breathing), and ingestion (eating) are the exposure routes evaluated. Exposure rates were estimated for typical and extreme application rates for ground applications.

In the typical setting, it was assumed that animals seek cover during a mechanical application and exposure is limited to contact with and ingestion of herbicide on or in leaves. In the extreme case, the animal was assumed to be sprayed. In both cases, mammals and birds were assumed to ingest herbicide while preening after touching treated vegetation.

In the typical case, the amount of herbicide-contaminated food was taken to be a percentage of the diet (based on the size of the animal's feeding territory). In the extreme case all food was assumed to be contaminated.

Total exposure was estimated by adding exposure by all routes (appendix A, section 7).

Aquatic species: Exposure was assumed to occur from herbicides that drift off-site during mechanical ground applications. Estimates of typical exposure were made using typical application rates and a 66 foot buffer between application site and the water. Estimation of extreme exposure was made using maximum application rate information and assuming only a 33-foot buffer.

Accident: Two aquatic accident scenarios were evaluated. In one, a single 5-gallon can (the largest can normally carried to the field on a pickup truck) of herbicide spilled into a pond; in the other, an emergency requires a helicopter pilot to dump a full 100-gallon tank load (the average tank size for helicopter applications) of chemical into a reservoir. Values of 5 gallon/pond and 100 gallon/reservoir are converted to parts per million in table 7-6 of the risk assessment (appendix A). In these cases, exposure through breathing (gills in contact with contaminated water) is more significant than in the terrestrial case or even for the extreme aquatic case.

Risk

Calculations of risk were based on a theoretical dose to animals in each typical, extreme, and accident situation. Risk is evaluated using EPA standards (EPA 1986). Predicted risk was compared with published standards to see if the herbicide or additive poses a greater or lesser risk. Practices which reduce risk to a level lower than the standard are noted as management requirements or mitigating measures in chapter II.

Inert Ingredients

See discussion in chapter IV, section B.

Data Gaps

When assessing herbicide effects on wildlife, we face an overwhelming number of species with data gaps and inconsistencies in data. The regulatory requirements (40 CFR 1502.22) described in the human health section (Chapter

IV, Section B) are addressed in this wildlife risk assessment. Response varies greatly among species, and differences among species are significant even within the same taxonomic grouping such as bird or fish. Ideally, to analyze effects on a species, data should be from tests on that species or a closely related one. Table 8-15 in the risk assessment (appendix A) summarizes the data gaps for several species of aquatic animals.

Data gaps which result in uncertainty about reasonably foreseeable significant adverse animal health effects include the following:

- Basic data about acute, subchronic and chronic toxicity are lacking for many animal groups; species-specific information are generally unavailable. Some mammalian data are available for all categories of acute toxicity but are unavailable for several chemicals for birds, insects, fish, aquatic invertebrates, and amphibians.

- Data on animal exposure to herbicide are unavailable. Dermal penetration rates, risk of exposure, and probable rate of exposure are not available.

- Field studies on chemical residue levels in or on plants in treated areas are lacking for most of the herbicides.

- Carcinogenic and mutagenic potential are unreported for most chemical/animal groupings.

- Data on synergistic effects of herbicides and inert ingredients on wildlife are not available.

- Data on cumulative/effects of herbicides on wildlife are unavailable.

- Data concerning relationships between specific chemicals and individual species' habitats are, for the most part, unavailable.

Filling data gaps is a extremely expensive process; individual tests cost between $50,000 (mutagenicity tests, etc.) and $2,500,000 (chronic toxicity tests, oncogenicity tests, etc.). As in the evaluation of human health effects, the Forest Service considers the accumulated costs of filling all of the data gaps prohibitive. Modeling is done to overcome missing or unavailable data.

The analysis to overcome missing and incomplete data is a risk assessment. This approach "is firmly based in scientific considerations... is a process of weighing alternatives and selecting the most appropriate actions" (National Research Council 1983). The risk assessment process provides modified worst case analyses (extreme and accident scenarios) which present reasonable foreseeable scenarios in which extreme exposure to herbicide occurs.

Throughout the analysis, data from tests on similar animals are used to estimate missing or incomplete information. Best conservative estimates were used. For example, a dermal penetration rate of 10 percent was assumed although it exceeds the most rapid rate of skin penetration reported.

Acute Toxicity

All of the herbicides evaluated were rated slightly toxic or very slightly toxic to rats when eaten (acute oral toxicity) except for the amine formulation of 2,4-D, which was rated moderately toxic (appendix A, table 6-1).

Studies of acute oral toxicity in birds (generally mallards (Anas platyrhynchos) or bobwhite quail) showed all to be slightly or very slightly toxic except for 2,4-D (ester and amine) which was moderately toxic. No avian studies were available for 2,4-DP or limonene.

Diesel oil has been demonstrated to be lethal to chicken embryos at a very low concentration in a single dose application (Weeks and others 1988). At rates significantly higher than normal field application rates, reduced egg viability was demonstrated for dicamba, fosamine, picloram, 2,4-D (amine and ester) and 2,4-DP. This latter information is of concern only in the accident scenario. No information was found for hexazinone, imazapyr, sulfometuron methyl, tebuthiuron, or triclopyr.

Using a scale proposed by Larry Atkins (University of California) all of the herbicides were rated relatively nontoxic (the least toxic category) to honeybees (Apis melliferu) except for dicamba (moderately toxic). The adjuvants limonene and diesel oil, however, were found to be highly toxic to honeybees. No information is available concerning the toxicity of kerosene to honeybees (appendix A).

The acute toxicity to fish of a given concentration of a chemical in water is rated on a scale of very highly toxic, highly toxic, moderately toxic, slightly toxic and practically nontoxic. Fosamine, glyphosate (Rodeo), imazapyr, tebuthiuron, triclopyr amine, and 2,4-D amine are classed as practically nontoxic; dicamba and sulfometuron methyl are classified as slightly toxic. Limonene is

classed as moderately toxic and, depending on which fish species is tested, glyphosate (Roundup), picloram, and 2,4-DP are rated moderately or slightly toxic. Triclopyr ester is rated highly toxic to fish while, depending on the test fish, 2,4-D ester and diesel oil are rated highly or moderately toxic, and kerosene is rated anywhere from highly to slightly toxic (appendix A, tables 6-8 through 6-19).

Toxicity to aquatic invertebrates is reported (appendix A, tables 6-8 through 6-19) as follows:

- Practically nontoxic: fosamine, glyphosate (Rodeo), imazapyr, tebuthiuron, and triclopyr.

- Slightly toxic: hexazinone, picloram, and sulfometuronmethyl.

- Moderately to slightly toxic: dicamba and glyphosate (Roundup).

- Moderately to practically nontoxic: 2,4-D amine.

- Highly to moderately toxic: 2,4-D ester, diesel oil, and kerosene.

- No information: 2,4-DP and limonene.

Toxicity data for amphibians is limited. 2,4-D amine and dicamba are classed by EPA as practically nontoxic; and picloram as slightly to practically nontoxic. No rating is available for the other chemicals.

Irritation

In addition to knowing the potential of a chemical to cause death, it is also necessary to know if it is an irritant to skin or eyes. The risk assessment presents data concerning the amount of each chemical which causes primary dermal or eye irritation.

Registration standards required under the Federal Insecticide, Fungicide, and Rodenticide Act were developed for the protection of humans and their environment. For humans a set of four classes has been developed to describe the effects on dermal and eye irritation. This same level of precision is not required for animals. Data presented in this section are for mammals; rats and rabbits are the chief test animals used to determine primary skin and eye effects, and are virtually the only ones tested so far.

Dermal: Dermal irritation was reported (appendix A) as follows:

- None: hexazinone, tebuthiuron, and 2,4-DP.

- None to slight: glyphosate, imazapyr, and sulfometuron methyl.

- Slight (or mild): dicamba, picloram, triclopyr ester, kerosene, and limonene.

- None to moderate: fosamine.

- Slight to moderate: triclopyr amine, and 2,4-D (amine and ester).

- Extreme: diesel oil.

Dermal exposure to diesel oil at a relatively high rate for three weeks caused death of the test animals. Dermal exposure to kerosene for 28 days at a rate significantly higher than expected in the field resulted in severe skin and liver lesions in rats. At one-half the rate that caused these undesirable effects, (a rate which is still significantly higher than expected in the field), no negative effects were observed (Weeks and others 1988) due to kerosene dermal exposure.

Eye: Eye irritation was reported (appendix A) as follows:

- None: fosamine (Krenite), diesel oil, and triclopyr ester.

- None to slight: glyphosate, imazapyr, and sulfometuron methyl.

- Slight (mild): picloram, tebuthiuron, 2,4-DP, kerosene, and limonene.

- Slight to moderate: dicamba and 2,4-D (amine and ester).

- Moderate to severe: fosamine (Krenite S) and triclopyr amine.

- "Irritating": hexazinone.

No Observed Effect Levels

The establishment of NOELs has been done primarily to develop human health guidelines. Animal testing is reported in the section on human health. Data do not exist for groups of animals other than mammals.

Effects of Inert Ingredients

A full discussion of the effects of inert ingredients is presented in the human health risk assessment summary. Kerosene is the only inert ingredient of toxicological concern in herbicides used in the Southern Region.

Acute Effects

The Environmental Protection Agency has published a standard for ecological risk assessment (EPA 1986). Standards from this publication are used in subsequent discussion.

Terrestrial: The EPA standard for evaluating risk from herbicides and other chemicals to terrestrial wildlife is the comparison of actual dosage with the LD_{50} (the amount of chemical which kills [Lethal Dose] one-half [50 percent] of the test animal population in an acute toxicity test). If the probable dose is less than one-fifth the LD_{50}, it is considered to pose an acceptable level of risk for terrestrial wildlife. Any dose greater than one-fifth of the LD_{50} is considered to pose unacceptable risk for terrestrial animals (EPA 1986).

The wildlife risk assessment presents the full evaluation of wildlife risk from herbicides applied at normal and extreme rates. Comparison of LD_{50} values with projected dose is presented in tables 8-4 through 8-14 of appendix A. A broad spectrum of animals is evaluated in the analysis; birds (common flicker, bobwhite quail, eastern bluebird, belted kingfisher, American kestrel, and red-cockaded woodpecker), mammals (southern short tailed shrew, red bat, eastern vole, grey squirrel, meadow vole, eastern cottontail, white tailed deer, cotton rat, eastern red fox, black bear, river otter, and bobcat), amphibian (woodhouse toad), reptiles (eastern box turtle, hognose snake, and gopher tortoise), and domestic animals (cow, chicken, and dog). Scientific names are presented in table 8-35 of appendix A.

Typical Scenario

Results presented in tables 8-4 through 8-14 of appendix A show that all 14 of the herbicides applied at typical rates pose less risk than allowed under the EPA standard.

Maximum Scenario

Results of the modeling of extreme rates are mixed. Dicamba, diesel oil, fosamine, glyphosate, imazapyr, kerosene, picloram, and sulfometuron methyl pose less risk than allowed by the EPA standard for all animals evaluated. Limonene also posed a lower risk than allowed, but data are unavailable to evaluate its effects on birds, reptiles, and amphibians. Dosage to several mammals is greater than allowable for hexazinone, tebuthiuron, and triclopyr; 2,4-DP showed greater than acceptable exposure for several birds and mammals; and 2,4-D showed unacceptable doses for some species in each of the terrestrial animal groups.

In summary, risk is at an acceptable level, according to EPA standards for terrestrial animals, for all wildlife when typical application rates of herbicides are used. Exceeding typical rates, times, or any of the other considerations which increases the dose of herbicide or additive received, can cause an unacceptable level of risk. Several of the herbicides evaluated had acceptable levels of risk at the maximum rate of application, however, several did not.

Aquatic: To evaluate the risk from herbicides in the aquatic environment, herbicide concentration is compared with the LC_{50} (the concentration of any substance in

water which will kill 1/2 of the test population; that is the Lethal Concentration for $_{50}$ percent of the test organisms.) The standard applied is: concentrations of less than one-tenth of the LC_{50} pose no acute health risk; concentrations between one-tenth and one-half the LC_{50} are presumed to pose a slight risk which can be mitigated; concentrations greater than one-half the LC_{50} pose presumptive significant risk to aquatic species of acute effects which can not be mitigated (EPA 1986).

The results of the risk assessment indicate that there is no significant risk of acute adverse effects to any of the representative aquatic species from drift either in a typical or maximum exposure situation.

Accident: Table IV-9 presents a summary of the risk resulting from a land accident in which 5 gallons of chemical are accidentally spilled into a pond (appendix A, tables 8-17 through 8-33. A spill of 2,4-D ester and triclopyr ester, 2,4-DP, diesel oil, glyphosate (Roundup), kerosene, and limonene pose significant risk to aquatic organisms. A spill of 2,4-D amine poses a slight risk to water fleas (*Daphnia* sp.) but none for other aquatic organisms. Dicamba, fosamine, glyphosate (Rodeo), hexazinone, imazapyr, picloram, tebuthiuron and triclopyr amine pose no risk to aquatic organisms from spills.

Table IV-10 shows the expected risk from an emergency aerial dump of 100 gallons of chemical into a reservoir (appendix A, tables 8-17 through 8-33). Only kerosene poses significant risk to aquatic organisms. 2,4-D ester, 2,4-DP, diesel oil, glyphosate (Roundup), and triclopyr ester pose slight risks to aquatic organisms, while 2,4-D amine, fosamine, glyphosate (Rodeo), hexazinone, imazapyr, limonene, picloram, sulfometuron methyl, tebuthiuron, and triclopyr amine are considered to pose no risk to aquatic animals.

Chronic and Cumulative Effects

Long-term studies have been performed on mammals to develop information for human health analyses (appendix A). These studies are given in the human health section. Studies evaluating the oncogenic or mutagenic potential of these chemicals on other animals (birds, reptiles, or amphibians) are not currently available. Chronic effects are highly improbable since it is unlikely that terrestrial animals would be exposed more than once in a lifetime from Forest Service activities. Where Forest Service lands border treated private lands, exposure could be more frequent, but still are unlikely to approach levels which could cause chronic health effects in wildlife.

Very limited information is available on chronic toxicity in aquatic animals for most chemicals (appendix A). There are no chronic toxicity data for dicamba, fosamine, either

Table IV-9.—Risk of exposure of fish and aquatic animals from an accidental terrestrial spill of herbicide or adjuvant. Terrestrial spill is assumed to be an amount equal to that carried in a a single container in a pickup truck (5 gal (19 l)). All chemical is assumed to reach the water (a pond). NR = No risk (according to the EPA standard) dose is less than 1/5 LC_{50}; SL = Slight risk (can be mitigated), dose between 1/5 and 1/2 LC_{50}; SE = Severe risk, dose is larger than 1/2 LC_{50}; — = No information available.

	2,4-D AMINE	2,4-D ESTER	2,4-DP	DICAMB	DIESEL	FOSAMI	GLYPHO RODEO	GLYPHO ROUNDU	HEXAZI	IMAZAP	KEROSE	LIMONE	PICLOR +2,4-D	SULFOM
Rainbow trout	NR	SE	SE	NR	SE	NR	NR	SE	NR	NR	SE	SE	NR	SL
Brook trout	NR	SE	SE	NR	SE	NR	NR	SE	NR	NR	SE	SE	NR	SL
Largemouth bass	NR	SE	SE	NR	SE	NR	NR	SE	NR	NR	SE	SE	NR	SL
Smallmouth bass	NR	SE	SE	NR	SE	NR	NR	SE	NR	NR	SE	SE	NR	SL
Bluegill	NR	SE	SE	NR	SE	NR	NR	SE	NR	NR	SE	SE	NR	SL
Green sunfish	NR	SE	SE	NR	SE	NR	NR	SE	NR	NR	SE	SE	NR	SL
Fathead minnow	NR	SE	SE	NR	SE	NR	NR	SE	NR	NR	SE	SE	NR	SL
Gizzard shad	NR	SE	SE	NR	SE	NR	NR	SE	NR	NR	SE	SE	NR	SL
Northern hogsucker	NR	SE	SE	NR	SE	NR	NR	SE	NR	NR	SE	SE	NR	SL
Mosquitofish	NR	SE	SE	NR	SE	NR	NR	SE	NR	NR	SE	SE	NR	SL
Chain pickerel	NR	SE	SE	NR	SE	NR	NR	SE	NR	NR	SE	SE	NR	SL
Crayfish	NR	NR	NR	—	SL	NR	—	NR	NR	—	NR	—	—	NR
Water flea	SL	SL	SL	NR	—	NR	NR	SL	NR	NR	—	—	NR	SL
Stonefly nymph	—	SE	SE	—	—	—	—	SL	—	—	—	—	NR	—
Virignia oyster	—	SL	SL	—	—	—	—	—	NR	—	—	—	NR	—
Mudpuppy	NR	—	—	NR	—	—	—	—	—	—	—	—	NR	—

	TEBUTH	TRICLO AMINE	TRICLO ESTER
Rainbow trout	NR	NR	SE
Brook trout	NR	NR	SE
Largemouth bass	NR	NR	SE
Smallmouth bass	NR	NR	SE
Bluegill	NR	NR	SE
Green sunfish	NR	NR	SE
Fathead minnow	NR	NR	SE
Gizzard shad	NR	NR	SE
Northern hogsucker	NR	NR	SE
Mosquitofish	NR	NR	SE
Chain pickerel	NR	NR	SE
Crayfish	NR	NR	—
Water flea	NR	NR	—
Stonefly nymph	—	—	—
Virignia oyster	NR	NR	—
Mudpuppy	—	—	—

Table IV-10.—Risk of unacceptable exposure of fish and aquatic animals from an accidental aerial spill of herbicide or adjuvant. Spill is assumed to be an emergency helecopter tank-dump of 100 gal (379 l). All chemical is assumed to reach the water (a resevoir). NR = No risk (according to the EPA standard) dose is less than 1/5 LC_{50}; SL = Slight risk (can be mitigated), dose between 1/5 and 1/2 LC_{50}; SE = Severe risk, dose is larger than 1/2 LC_{50}; — = No information available.

	2,4-D AMINE	2,4-D ESTER	2,4-DP	DIESEL	FOSAMI	GLYPHO RODEO	GLYPHO ROUNDU	HEXAZI	IMAZAP	KEROSE	LIMONE	PICLOR +2,4-D	SULFOM	TEBUTH
Rainbow trout	NR	SL	SL	SL	NR	NR	SL	NR	NR	SE	NR	NR	NR	NR
Brook trout	NR	SL	SL	SL	NR	NR	SL	NR	NR	SE	NR	NR	NR	NR
Largemouth bass	NR	SL	SL	SL	NR	NR	NR	NR	NR	SE	NR	NR	NR	NR
Smallmouth bass	NR	SL	SL	SL	NR	NR	NR	NR	NR	SE	NR	NR	NR	NR
Bluegill	NR	SL	SL	SL	NR	NR	NR	NR	NR	SE	NR	NR	NR	NR
Green sunfish	NR	SL	SL	SL	NR	NR	NR	NR	NR	SE	NR	NR	NR	NR
Fathead minnow	NR	NR	NR	SL	NR	NR	NR	NR	NR	SE	NR	NR	NR	NR
Gizzard shad	NR	SL	SL	SL	NR	NR	SL	NR	NR	SE	NR	NR	NR	NR
Northern hogsucker	NR	SL	NR	SL	NR	NR	SL	NR	NR	SE	NR	NR	NR	NR
Mosquitofish	NR	SL	SL	SL	NR	NR	SL	NR	NR	SE	NR	NR	NR	NR
Chain pickerel	NR	SL	SL	SL	NR	NR	SL	NR	NR	SE	NR	NR	NR	NR
Crayfish	NR	NR	NR	NR	NR	—	NR	NR	—	NR	—	—	NR	NR
Water flea	NR	NR	NR	—	NR	NR	NR	NR	NR	—	—	NR	NR	NR
Stonefly—ymph	—	SL	NR	—	—	—	NR	—	—	—	—	NR	—	—
Virignia oyster	—	NR	NR	—	—	—	—	NR	—	—	—	NR	—	NR
Mudpuppy	NR	—	—	—	—	—	—	—	—	—	—	NR	—	—

	TRICLO AMINE	TRICLO ESTER
Rainbow trout	NR	SL
Brook trout	NR	SL
Largemouth bass	NR	SL
Smallmouth bass	NR	SL
Bluegill	NR	SL
Green sunfish	NR	SL
Fathead minnow	NR	SL
Gizzard shad	NR	SL
Northern hogsucker	NR	SL
Mosquitofish	NR	SL
Chain pickerel	NR	SL
Crayfish	NR	—
Water flea	NR	—
Stonefly—ymph	—	—
Virignia oyster	NR	—
Mudpuppy	—	—

glyphosate formulation, imazapyr, or limonene. There are only single species data for 2,4-D ester, sulfometuron methyl, and the ester and amine formulations of triclopyr. Reasonably good data exist only for 2,4-D amine.

Risks of chronic effects, such as reproductive success or long-term survival, were estimated for aquatic organisms for those herbicides and species where sufficient data were available (appendix A). In no case was significant risk of adverse effect identified.

Cumulative poisoning of animals from a herbicide will result only if that substance bioaccumulates in the body. Tebuthiuron shows a slight tendency to accumulate in fish, but none of the other herbicides for which data are available show any tendency to accumulate (table 3-4, appendix A). Consequently, risk from cumulative exposure is not expected to exceed other risks discussed in the risk assessment. Furthermore, herbicide mixtures used in the Coastal Plain/Piedmont have not shown synergistic effects.

b. Effects on Habitat

Herbicides have an indirect effect on wildlife by altering vegetation species composition and structure. Depending on the herbicide applied, application rate and method, and vegetation affected, treatments can be detrimental to some wildlife species and beneficial to others. Herbicide effects on wildlife can include an increase in snag availability, or a reduction or increase in hard-mast production, soft mast production, ground vegetation (forbs, grasses), and foliage height diversity (layers of vegetation present within a stand).

Habitat Alteration From Site Preparation

To prepare a site for regeneration, herbicides may be applied alone or in combination with prescribed fire or mechanical treatment. Site preparation may be accomplished by broadcast application or by treating individual stems by injection, thinline, or foliar spray application of herbicides. Sites prepared by herbicide without mechanical treatment support a greater diversity and abundance of bird populations (Darden 1980) because of downed and standing woody material.

When herbicides are applied in bands rather than broadcast over an entire area, deer forage production is slightly higher the first year (Blake 1986b). Site preparation by herbicides alone results in numerous snags which provide perching sites for raptors (hawks and owls) and potential nest sites and foraging habitat for cavity-nesting and insect-feeding birds. This habitat results in an overall increase of bird diversity in treated clearcuts (Dickson and others 1983; Warren and others 1984). Removal of shading vegetation may adversely affect reptile and amphibian species, but fallen snags eventually create cover for amphibians and sunning sites for reptiles.

Herbicides used with fire usually result in a stand with sparse ground cover at first. Mourning doves and small mammals such as cotton rats (Sigmodon hispidus) find early successional stages attractive (McComb and Hurst 1987; Perkins 1973). Production of preferred deer forage can increase for several years following treatment with herbicides such as 2,4-D (Hurst and Warren 1981). Herbicides such as glyphosate reduce grass and herbaceous species the year following treatment but production recovers during the second growing season (Copeland and Hurst 1986).

Habitat Alteration From Pine Release

Treatment of pine stands at 3-6 years of age to control hardwood stems tends to encourage growth of grass, forbs, and vines. This improves conditions for ground-feeding birds, white-tailed deer, and wild turkey by increasing seeds and forage (Hurst and Warren 1986). When applied by broadcast methods, however, these treatments reduce the number of soft-mast producers such as vacciniums and dogwood, which are used by many species of wildlife. Herbicide applications which result in top-kill of hardwoods tend to reduce mast production by relegating many mast-producers to the midstory of the future stand. Root-kill applications cause a more serious reduction by eliminating certain mast-producers altogether. This can have a detrimental effect on deer, turkey, gray squirrels, and many species of songbirds.

Release by selective methods such as spot-around or foliar spray makes it possible to leave individual stems or clumps of mast-producing or other desirable hardwoods. Studies of stands treated with 2,4-D show that retaining even small scattered patches of brush helps maintain bird density and abundance after treatment (Morrison and Meslow 1984b).

The use of herbicides such as glyphosate, which control grasses and herbaceous vegetation, results in temporary reduction in forage. But species composition, total biomass, and forage production are usually similar to untreated areas by the second growing season (McComb and Hurst 1987).

The accelerated growth of pine which results from successful release treatment may benefit some wildlife species because it allows pine stands to be burned and thinned sooner (Owen 1984). Broadcast application of imazapyr increases production of forbs and vines, including important deer forage species like blackberry and dewberry, while reducing woody browse (Hurst 1987).

Habitat Alteration From Stand Improvement

When used for timber stand improvement (TSI), injection of competing hardwood stems in mixed pine-hardwood stands reduces hard-and soft-mast producing trees unless selected stems are left. This reduction harms species such as white-tailed deer, gray squirrel, and many songbirds. Increased snag availability, however, benefits cavity nesters and small mammals that will use openings created in the stand (McComb and Rumsey 1982). Snags created by herbicides tend to remain standing for a shorter time than those created by other means such as girdling (Conner and others 1983). Shrub fruit-producers and vines such as honeysuckle increase, benefiting white-tailed deer and many birds. Increased pine seed production benefits fox squirrels and other species.

In the short run and possibly in the long run, bird abundance and diversity increases when some of the overstory in upland hardwood stands is removed by broadcasting picloram or 2,4-D. The increase is probably due to the resulting increase in the diversity of vegetation layers (McComb and Rumsey 1983b; Morrison and Meslow 1984a, 1984b.) Habitat for foliage-gleaning birds, however, may be reduced.

Applied selectively for wildlife stand improvement (WSI), herbicides release mast-producing hardwoods and increase mast production for deer, turkey, squirrel, bear, and other species. When hardwood midstories are reduced, production of deer forage increases, especially when prescribed fire is also applied (Blair and Feduccia 1977).

Habitat Alteration From Rights-of-Way (ROW) and Openings Maintenance

Wildlife openings and rights-of-way corridors provide early successional stage habitat. Such habitats vary from grass/forb to brush cover depending upon how they are maintained. They also provide transitional zones or "edge," which may increase species diversity. When ROWs transect and fragment large intermediate or mature hardwood stands, some bird species which need large stands to reduce nest

parasitism and predation may decline. Although little research exists, naturally created edges (as by wildfire) may reduce this effect compared to abrupt artificial edges (Reese and Ratti, in press).

Use of herbicides in wildlife openings maintenance is usually directed at control of persistent non-native grasses such as fescue or control of encroaching hardwood brush. This treatment helps in establishment of native or other grasses, legumes, and forbs.

Herbicides on ROW corridors may be broadcast or selective. Repeated treatments may result in a low-shrub community which is stable and resistant to invasion by tree species. Such a community develops more rapidly and without the initial loss of brush cover when selective spraying is used (Eaton and Gates 1979). It usually has a substantial soft-mast producing component, and is more beneficial to some small mammals and deer than a grass-forb community (Ladino and Gates 1979). Arner (Mississippi State University, personal communication), however, found that this type of treatment in Mississippi tended to favor sumacs (_Rhus_ spp.) rather than fruit-producers such as vacciniums which are more valuable to many species of wildlife. When the shrub cover is patchy and varying in height, a greater diversity of bird species will occur (Kroodsma 1982).

Selective herbicide application to brush or trees that reach a predetermined height results in habitat favorable for white-tailed deer (Bramble and others 1985) and some songbirds (Kroodsma 1982; Myers and Provost 1979).

Habitat Alteration From Range Treatment

Herbicides are used to reduce encroachment of brush on grasslands managed for grazing. Control of brush in small blocks or strips is generally beneficial to deer and turkey. Total control of brush harms many species of songbirds, small mammals, and raptors (Holechek 1981).

2. Effects of Prescribed Fire

a. Direct Mortality

Because most animals in the Coastal Plain/Piedmont are adapted to periodic fires of natural and man-caused origin, direct mortality from prescribed fire has a negligible effect upon animal populations (Lyon and others 1978). Less mobile species such as shedding diamondback rattlesnakes (_Crotalus adamanteus_) (Means and Campbell 1981) or frogs (Vogl 1973) may occasionally be killed. Most observers, however, indicate that this is rare (Komarek 1969) and that mortality is not normally associated with slow-moving prescribed fires. Furthermore, even fires started by an aerial ignition pattern which results in numerous spot fires rather than linear flame fronts do not result in significant vertebrate mortality (Folk and Bales 1982). A notable exception is the Eastern glass lizard (_Ophisaurus ventrali_) which may be killed in considerable numbers when prescribed burns are conducted (Means and Campbell 1981).

Larger animals such as white-tailed deer usually move calmly away from advancing fires. There is no evidence that wildlife is harmed by smoke. Raptors, bobwhite quail, turkey, and insectivorous birds are often attracted to recently burned or actively burning and smoking areas (Komarek 1969; Landers 1987; Lyon and others 1978; Stoddard 1963). When burns are conducted during the nesting season, some eggs and young of ground-nesting species are destroyed. Although it is possible for direct heating of water bodies by wildfire to result in the mortality of aquatic organisms, mitigation measures do not allow prescribed fires to achieve the intensities or duration necessary for this to occur.

b. Effects on Habitat

Because lightning-set and man-caused fires have occurred periodically in the Coastal Plain/Piedmont for several thousand years, animals have adapted to habitats subjected to recurring fires. Some, like bobwhite quail, depend upon fire to maintain their environment (Landers 1987).

Prescribed burning affects different species in different ways. Some effects on wildlife habitats include an increase in the amount, availability, and palatability of forage; changes in production of soft mast; changes in invertebrate populations; and the creation and destruction of snags (Van Lear and Johnson 1983).

Without periodic prescribed burning in most southern pine types, increased fuels increase the occurrence of intense and unplanned wildfires. Habitat alteration from these fires is often severe since overstory vegetation, as well as smaller woody stems, may be destroyed.

A major research need in the area of prescribed fire is the relationship of prescribed fire effects to fire behavior. In other words, how do intensity, duration, and season of burning affect various wildlife species? Data related to effects of burning on many species in the South, particularly songbirds, reptiles, and amphibians, are meager.

Habitat Alteration From Site Preparation

Prescribed fire is used alone or with herbicide or mechanical treatments. Depending upon intensity, broadcast burns may remove very little to virtually all live vegetation and residue. This condition is temporary, however, because roots, bulbs, and dormant seeds are stimulated by fire and soon sprout. Conditions soon become favorable to ground feeders like meadowlarks (*Sturnella magna*). Deer forage and production of seeds used by birds such as quail increase dramatically, peaking the first or second season after burning (Stransky and Halls 1978; Warren 1980.) After 2 or 3 years, conditions improve for species such as cottontail rabbits and cotton rats. Fruits important to species such as black bear decrease initially but soon increase (Hamilton 1981).

Except for intense fires that destroy much of the ground cover and increase sedimentation risk on small streams, prescribed burns have little impact on Coastal Plain/Piedmont fish populations (Seehorn 1987).

Habitat Alteration From Stand Improvement

Prescribed underburns are carried out in pine and mixed pine-hardwood stands ranging from saplings to mature stands. Whether they are used to improve conditions for wildlife or range, reduce hazardous fuels, or control competing vegetation, their effects on wildlife are similar. Effects vary, however, according to season, intensity, and frequency of burns.

Burning has long been used as a tool in the Coastal Plain/Piedmont to improve white-tailed deer habitat. Research indicates that nutrient content (particularly protein and phosphorous) and palatability of deer food increase temporarily after burning. Also, fruit yields of understory shrubs decrease immediately, then increase to levels higher than before burning and decline gradually. Optimum fruit production probably occurs when pine stands are burned every three years (Johnson and Landers 1978). In addition, deer browse decreases initially, but increases rapidly for several years afterward (Stransky and Harlow 1981; Blair and Enghart 1976; Hurst and Warren 1982). Browse after burning generally grows out of the reach of deer after 4-5 years (Landers 1987). Repeated burns, particularly during the growing season, may reduce the amount of woody vines such as honeysuckle, an important deer food (Landers 1987). Consequently, protecting some areas from burning is important.

Periodic dormant-season burning of scattered areas probably benefits black bear because it increases production of some fruits and succulent saw palmetto shoots (Hamilton 1981). Prescribed burning benefits most fur-bearers because fire increases prey abundance and availability. Burns also increase production of fruits such as blackberry and blueberry. Production of important foods such as persimmon and grapes, however, may decline (Johnson and Landers 1978; Miller and Speake 1978).

Many small mammals need the early successional forest stages created or maintained by fire. Long-term studies indicate that rodents such as the eastern harvest mouse (*Reithrodontomys humulis*) and hispid cotton rat, which feed on seeds and grass, usually increase after prescribed fire. Insectivorous mammals like short-tailed shrews tend to decrease (Baker (unpublished) in Landers 1987). Other (short-term) studies have shown immediate reductions of mice and rats accompanied by increases of shrews (Landers 1987). When fire is used to control hardwoods in pine

stands, it generally has a negative impact on squirrels since it reduces future production of acorns. This is particularly true where fire is used to maintain a wiregrass community (Landers 1987). Fire may be beneficial to gray squirrels, however, when it is used to maintain low-growing oak species or promote a lush groundcover which provides escape cover (Hillard 1979). Habitat will generally remain suitable for squirrels as long as scattered patches of mast-producing hardwoods remain interspersed in pine stands (Landers 1987). Prescribed fire, particularly patchy burning done annually or biennially, appears to be beneficial to rabbits (Hill 1981).

Annual or biennial dormant-season burning for quail is a common management tool in the Coastal Plain/Piedmont. Most managers agree that fire should be excluded from some areas to provide 2-3 year old roughs necessary for nesting cover and soft-mast production (Hurst 1981; Landers 1981; McRae and others 1979). Burning for management of wild turkey is also common, although it is generally conducted on a longer (3-5 year) rotation than burns for quail management. Benefits include increases in legumes, reduction in external parasites, maintenance of brood habitat for poults, and increases in the arthropod food supply. Early growing season burns or burning less frequently than every 5 years may reduce lespedezas and other legumes important as food sources for quail and turkey (Lewis and Harshbarger 1976, 1986; Speake 1966). Decline in hard-mast, important for turkey, squirrels, and many other species, may result from repeated burning.

Burning has effects on other bird species as well. Prescribed fires may eliminate standing dead trees that provide cavity nest sites. However, fires also kill trees, thus providing sites for new cavities (Conner 1981). According to Dickson (1981), burning increases early successional species such as Bachman's sparrow (*Aimophila aestivalis*) and birds such as pine warblers (*Dendroica pinus*) which inhabit intermediate to mature pine stands. When variations in fire behavior result in patchy vegetation, bird diversity tends to increase (Landers 1987).

Periodic burning helps to temporarily provide open conditions. Such conditions make hunting of small mammals and birds by hawks easier, and tend to attract many species of predatory birds. Red-tailed hawks (*Buteo jamaicensis*), kestrels (*Falco sparverius*), and loggerhead shrikes (*Lanius ludovicianus*) often feed in freshly burned areas (Komarek 1969).

Little research exists on fire effects on reptiles and amphibians in the South. It is apparent, however, that frequent burning of the sandhills community apparently helps

maintain a high diversity of "sand-swimming" reptiles which inhabit loose sand (Mushinsky 1985). Bog species like the pine barrens treefrog (Hyla andersoni) benefit when prescribed fire is used to control encroachment of woody species (Means and Moler 1979).

Most prescribed underburns are conducted during the dormant season. But the need for growing-season burns to perpetuate the longleaf pine/wiregrass community and its associated wildlife species in Florida has recently been debated. Season of burning is important since early growing-season burns apparently favor grasses and forbs while late growing-season burns favor low, fruit-producing shrubs, runner oak acorns, and perennial legumes. Dormant-season burns favor annual legumes and woody vegetation. Burning during the early growing season probably resembles the natural regime of lightning-ignited fires under which animals inhabiting this type evolved. Exclusion of fire from this ecosystem gradually degrades the habitat which supports a unique association of plants and animals.

Growing-season burning may be most beneficial for many wildlife species when it is alternated with dormant-season burns (personal communication, Bill Platt, Tall Timbers Research Station).

Habitat Alteration From ROW and Openings Maintenance

Prescribed fire is not commonly used in the Coastal Plain/Piedmont as a means of managing vegetation in openings and ROWs. Limited research indicates that compared to mechanical or herbicide treatments, dormant-season burning produces more arthropods and insects for birds to feed on (Hurst 1970) and may produce more legumes and other plants used by birds like quail (Huntley and Arner 1979).

Habitat Alteration From Range Treatments

Prescribed burning for range produces responses similar to those of stand improvement burns. In addition to improving forage quantity and quality for cattle, range burns improve browse conditions for deer. In longleaf pine-bluestem range, burning also lessens competition between cattle and deer by reducing the amount of diet overlap between the species (Thill 1982).

3. Effects of Mechanical Treatments

a. Direct Mortality

Mechanical methods occasionally cause direct mortality of adult animals or result in destruction of eggs or young. Normally, vertebrate species are able to flee in advance of equipment and escape harm, although some reptiles and amphibians may be killed. Mowing, chopping, shearing, raking, disking, and other mechanical tools cause some direct mortality to invertebrates, but, because of large populations and high reproductive rates, populations are not hurt. Destruction of eggs and young depends upon season of treatment and can occur when equipment is used during the nesting season.

Disturbance caused by equipment used for site preparation may result in abandonment of young or nests. With larger vertebrates such as deer or rabbits, such abandonment is normally temporary. Ground-nesting birds may permanently abandon nests if disturbance occurs soon after nesting begins but will tolerate greater disturbance when eggs are close to hatching. Although most ground-nesters will renest, survival rates for young from late-season nesting attempts are generally lower.

b. Effects On Habitat

Specific research on the effects of mechanical treatments on many species is scarce. Fortunately, since data regarding the effects of mechanical treatments on vegetation structure and species composition are available, conclusions regarding effects on wildlife can be made. In some ways, effects are similar to those resulting from herbicide or fire, but vary depending on the degree to which root stocks are destroyed.

Habitat Alteration From Site Preparation

As with prescribed burning, most mechanical site preparation treatments increase the number of plant species and amount of herbaceous ground cover as compared with uncut, mature forest stands. More intensive mechanical methods, however, such as raking or disking reduce the number of woody fruit-producers (Swindel and others 1984; Stransky and Halls 1980; Stransky and Roese 1984).

Small seed-eating mammals that use early successional habitat benefit more from mechanical site preparation if windrows, scattered brush cover, and downed logs are not removed (as by burning) (Buckner and others 1979). Rabbits and many reptiles and amphibians benefit as well. Short-term (up to age 5) increases in deer forage following mechanical treatments can be dramatic. Chopping, which does not destroy plant root systems, generally results in higher browse production than more intensive methods (Stransky and Halls 1979). Sites prepared by bedding seem to attract fewer rabbits than do sheared or chopped sites (McKee 1973).

When intensive mechanical treatments such as shear, rake, and windrow are used in conjunction with burning, soft-mast species such as blackberry and pokeweed soon invade (Campo and Hurst 1980). These open sites attract ground feeders such as mourning doves the first year following treatment. As more cover becomes available (2-3 years), species such as bobwhite quail utilize the site. Turkey use the areas for nesting cover as well. Retaining windrows also increases use by species such as house wrens (Troglodytes aedon) (Rowse and Marion 1980). With all site preparation methods, retention of snags greatly increases use by cavity nesters and raptors.

Based on limited research, it appears that intensive treatments which remove debris reduce the numbers of reptiles and amphibians. However, intensive treatments may provide habitat for tree-dwelling reptiles sooner than less-intensive treatments. A patchy distribution of habitats allows for more rapid recolonization after treatment (Enge and Marion 1985).

Fish and other aquatic organisms are harmed when erosion caused by soil disturbance results in stream siltation. Where streamside buffer strips and proper techniques (such as using a sharp dozer blade and not allowing the blade to penetrate below the ground) are used, siltation is insignificant (Seehorn 1987). Streamside zones also provide shade which is necessary for maintaining water temperatures required by aquatic organisms.

When deposited in streams, excessive slash created by site preparation harms fish populations by reducing dissolved oxygen and trapping sediment. Small amounts of slash, however, when properly placed, enhance fish habitat (Seehorn 1987).

Habitat Alteration From Other Stand Treatments

Use of mechanical treatments for other purposes is minor. Effects are similar to those discussed in the preceding section. Chopping for pine release helps species such as deer by opening strips in dense stands, thus increasing production of forbs and legumes.

Habitat Alteration From ROW and Openings Maintenance

Mowing is the primary mechanical method for maintaining ROWs and wildlife openings. Mowing maintains a grassy groundcover which can provide nesting and bugging habitat for turkey, and cover for several species of rodents. Frequent

mowing, however, reduces cover for species like cotton rats and ground-nesting birds (Schmidly and Wilkins 1977). Less-frequent mowing and strip mowing benefits most wildlife species found in ROWs because such practices leave islands of cover for nesting and escape.

Light disking is sometimes used to break-up grass cover and encourage native legumes, which are an important food for ground-feeders like quail.

4. Effects of Manual Treatments

It is unlikely that manual methods cause any direct mortality except when removal of brush or trees destroys nests or young. Effects on habitat are similar to those described for mechanical techniques which do not disturb the soil. Human disturbance may cause temporary or permanent abandonment of young or nests. Losses are minor and can be reduced if workers resist the temptation to "rescue" apparently orphaned animals. Normally, disturbance is short-lived, as workers move on to untreated areas and animals return.

5. Effects of Biological Treatments

Insignificant direct mortality occurs when livestock trample nests or the young of ground-nesting birds. Also, there is a potential for transmission of diseases such as epizootic hemorrhagic disease (which affects deer) from livestock to wildlife populations.

In the pine lands of the Coastal Plain/Piedmont, heavy year-round grazing reduces quality of habitat for many wildlife species. Research indicates, however, that light to moderate cattle grazing generally has little adverse impact on seed-producing plants important to ground feeders (Lewis and Harshbarger 1986). Short periods of intense grazing tend to reduce grasses and increase forbs eaten by deer and turkey (Moore and Terry 1979).

E. THREATENED, ENDANGERED, PROPOSED, AND SENSITIVE SPECIES

Introduction

The generalizations regarding effects of vegetation management on wildlife presented in section D also apply to species listed as threatened, endangered, proposed, and sensitive. Procedures outlined in chapter II, including the site-specific biological evaluation and environmental assessment processes, are designed to ensure that these species are protected when vegetation management projects take place. Forest inventories, Forest Land and Resource Management Plans, recovery plans, and Forest Service Handbook chapters are also important.

Some threatened or endangered species, such as the West Indian manatee, American alligator and flattened musk turtle, occur in aquatic habitats protected by buffers. Sensitive species identified with a "NO" in table III-7 are also unaffected for the same reason. The golden eagle,

another sensitive species, is only an occassional winter visitor to the Coastal Plain/Piedmont and consequently is unaffected. The hairy-lipped fern and other sensitive plants labled in table III-8 with a "NO" are found only in habitats where no vegetation management takes place and are therefore unaffected.

For certain other species, particularly those adapted to a disturbance-related environment, use of vegetation management techniques such as prescribed burning to mimic natural disturbances is essential for continued species viability. The red-cockaded woodpecker, for example, requires open pine stands without a hardwood midstory. Prescribed fire on a 2-3 year rotation will maintain habitat that is already suitable. Herbicide, manual or mechanical treatments, or growing season burns are required to control hardwood stems larger than 2 inches and restore habitat suitability to colony sites with encroaching hardwoods (FSH 2609.23R R8 AMEND 13).

As discussed in chapter II, recovery plans and Forest Service Handbook chapters have been prepared for several threatened, endangered, and proposed species. With some of these species, factors such as poaching or loss of critical habitat outside of national forests combine to hinder species recovery. Recovery plans and handbook chapters consider these factors when establishing guidelines for Forest Service practices which may affect threatened, endangered, and proposed species.

There is a need for recovery plans and handbook chapters to be prepared for each of these species in the Southern Region and for each national forest to prepare guidelines for protecting and managing sensitive species occurring on the forests.

General effects of vegetation management methods on threatened, endangered, proposed, and sensitive species are presented in tables D-1 through D-6 in appendix D (the biological evaluation for this document). Measures to mitigate these effects are presented in appendix D and in chapter II.

1. Effects of Herbicides

Terrestrial Species

The EPA standard for chemical exposure considers a dose of less than 1/10 LD50 as not presenting a significant risk for a threatened or endangered terrestrial species. Based on toxicity data and exposure predictions made in the risk assesment, most of the herbicides analysed do not present a significant risk to any threatened, endangered, or proposed species when applied at typical rates. There is a probability of siginificant risk (dose exceeds 1/10 LD50), however, from 2,4-D and 2,4-DP to the Florida scrub jay, Indiana bat, and gray bat. Siginificant risk exists as well

from exposure of the Indiana and gray bat to triclopyr. 2,4-D also presents a significant risk to the following sensitive species: star-nosed mole, Florida mouse, old-field mouse, masked shrew, southern shrew, southern pygmy shrew, and red-backed vole.

If applied at extreme rates, 2,4-D, 2,4-DP, dicamba, hexazinone, tebuthiuron, and triclopyr present a significant risk to most of the threatened, endangered, and proposed species listed in table III-5 and most of the sensitive species listed in III-7.

Low toxicities, low risk of exposure, and mitigation measures (detailed in chapter II) governing the use and handling of herbicides, combined with requirements for site-specific inventories and environmental assesment, make the probability of direct toxic effects on threatened, endangered, proposed, or sensitive animals low. Key mitigation measures include a prohibition on application at extreme rates and limitations on use of herbicides identified in this chapter as posing significant risk.

Aquatic Species

The EPA standard for theatened, endangered, or proposed aquatic animals identifies an exposure of greater than 1/20 LC50 as presenting a significant risk. Based on predictions regarding exposure of the representative species analysed in the risk assessment to two accidental spill scenarios, the endangered shortnose sturgeon and Louisiana pearl mussel face a significant risk from a spill of 2,4-D ester, 2,4-DP, diesel oil, the ester formulation of glyphosate, kerosene, limonene, sulfometuron, and the ester formulation of triclopyr.

An accidental spill of these chemicals poses a significant risk to the following sensitive aquatic animals as well: Suwannee bass, flame chub, crystal darter, freckled darter, bluenose shiner, Lake Eustis shiner, Sabine shiner, gulf sturgeon.

Mitigating measures in chapter II regarding the transportation, handling, and application of herbicides are designed to make the likelihood of such an accidental spill very small.

Plant Species

Threatened, endangered, proposed, and sensitive plant species can be extremely sensitive to the effects of herbicides and direct treatment can destroy a local population. If the population is isolated, as many are, there may be means for natural reestablishment. Response varies depending on several factors. Dicamba, for instance, might kill Florida gooseberry, a woody plant, but have little effect on a herbaceous species like Ocala vetch. Stem injection of hardwoods with picloram would not threaten

a nearby population of Oglethorpe oak, whereas foliar spraying might. Although risk is lower when a herbicide has low efficacy for controlling a particular plant species, all of the herbicides analyzed are toxic to any plant when applied at sufficient rates, and are considered to pose a significant risk to all threatened, endangered, proposed, and sensitive plants occurring in the Coastal Plain/Piedmont when they are applied by broadcast methods. This risk may be mitigated by conducting site-specific inventories and environmental assessments and by carefully selecting chemical, rate, method and season of application (see chapter II).

2. Effects of Prescribed Fire

Some plant species are stimulated by fire. Others, like the Florida gooseberry are harmed and should be protected. Several species are associated with habitats that are created or maintained by fire. For example, without periodic burning, habitat for the red-cockaded woodpecker, parrot pitcher plant, and Mississippi sandhill crane becomes unsuitable. Past exclusion of fire from these species' habitat has hastened their decline. Season and intensity of burning, however, must be controlled to prevent habitat damage.

3. Effects of Mechanical

Most threatened, endangered, or proposed plant species are harmed by mechanical treatments, particularly those techniques that disturb the soil. Some plants may benefit by release from competing vegetation or be stimulated to reproduce.

As with burning, mechanical treatments may either harm or benefit these species. Gopher tortoises, for example, may benefit from treatments such as chopping (combined with herbicide application or burning). These treatments allow a rapid reinvasion by groundcover plants used by the tortoise. But the animal may be harmed by soil-disturbing treatments like heavy disking.

4. Effects of Manual

Manual treatments are less likely than mechanical treatments to be harmful to threatened, endangered, proposed, or sensitive plants since they do not disturb soil or root systems. Most woody species will respond by resprouting, but others may be killed if treated directly.

5. Effects of Biological

Some plants may respond favorably to light grazing. Others, such as Biltmore sedge, should be protected from foraging animals.

As with other species, heavy, continuous grazing damages habitat. Short-duration grazing, however, may benefit some species like gopher tortoise by causing vegetation response similar to that caused by wild herbivores (American bison) which formerly occupied their range.

F. SOIL

Introduction

Productivity, a site's ability to grow vegetation over time, depends on physical, chemical, and biological qualities of the soil. Productive soils have loose and porous structure, ample reserves of organic matter and nutrients, and balanced populations of small organisms.

Sensitivity to disturbance varies with type of soil. Depleted soils recovering from past severe farmland erosion are unproductive and highly sensitive. Poor soils (entisols, inceptisols, spodosols, and partly eroded soils) are rather unproductive and moderately sensitive. Rich soils are productive and slightly sensitive (table IV-11).

Table IV-11.--Distribution of depleted, poor, and rich soils in the various landtypes*

	--------Percent of Landtype-------		
Landtype	Depleted	Poor	Rich
COASTAL PLAIN			
Cross Timbers	--	--	100
Clay Prairies	--	--	100
Upper Hills	15	30	55
Rolling Uplands	--	--	100
Clay Lowlands	--	--	100
Loess Uplands	20	50	30
Mississippi Valley	--	--	100
Gulf Flatwoods	--	50	50
Atlantic Flatwoods	--	20	80
Sand Ridges	--	70	30
PIEDMONT	30	50	20

*See Figure IV-3, section G (Water) for map of landtypes

1. Effects of Prescribed Fire

There are three main types of prescribed fire: (1) slash burns in harvested stands; (2) underburns beneath stands; and (3) grassland burns. Effects on soil vary with type of burn (Maxwell, appendix B).

Slash burns occur once every 40-80 years for site preparation. Risks of adverse effects depend mostly on fire severity. Fire severity differs from fire intensity. An intense slash burn done when duff, soil, and larger fuels are moist will seldom be severe (Van Lear and Danielovich 1988). Fire severity is defined by ground condition after the burn (Wells and others 1979).

Underburns occur every 1-7 years and are light to moderate in severity. Favorable effects are enhanced phosphorus cycling and reduced soil acidity (McKee 1982). Risks of adverse effects depend on frequency and season of burn.

Like underburns, grassland burns occur every 1-7 years and are light to moderate in severity. Risks of adverse effects depend mostly on frequency of burn.

Prescribed fire may affect soil productivity through soil heating, soil erosion, and nutrient leaching. Soil heating can kill soil biota, alter soil structure, consume organic matter, and remove site nutrients during the burn. Soil erosion and nutrient leaching occur during later rainstorms and cause smaller nutrient losses (Maxwell, appendix B).

Soil Heating

Light slash burns merely scorch the litter and duff on most of the area. Soil heating does not significantly affect soil biota, structure, or organic matter. Less than 150 lb/ac of nitrogen is released as gas from slash, litter, and duff. Effects on other soil nutrients (phosphorus, potassium, calcium, magnesium) are favorable (Maxwell, appendix B).

Moderate slash burns char and partly consume the litter and duff on most of the area. Soil biota are reduced but recover quickly. Soil structure is not affected. Much litter and duff may be consumed, but soil organic matter is not significantly reduced. Between 300 and 350 lb/ac of nitrogen may be released as gas from slash, litter and duff, and soil. Other soil nutrients are not significantly affected (Maxwell, appendix B).

Severe slash burns consume all litter and duff and alter mineral soil on most of the area. Destruction of soil biota sterilizes the site and full recovery takes years. Soil porosity, infiltration, and moisture capacity are reduced. At least 90 percent of litter and duff and 50 percent of topsoil organic matter are often consumed. Between 650 and 850 lb/ac of nitrogen may be released as gas from slash, litter and duff, and topsoil (Maxwell, appendix B).

Underburns more frequent than every 3 years do not affect soil biota, but litter-duff biota are reduced and do not fully recover before the next burn. Loss of organic matter exceeds 10 percent. Nitrogen loss may be up to 160 lb/ac for dormant season burns and 600 lb/ac for growing season burns. Annual underburns also impair soil porosity and infiltration (Maxwell, appendix B).

Dormant season underburns every 3-4 years allow litter-duff biota to fully recover between burns. Soil physical properties are not affected. Loss of organic matter is about 5 percent. Nitrogen loss may be 100-150 lb/ac (Maxwell, appendix B).

Growing season underburns every 3-4 years also reduce organic matter by about 5 percent. Nitrogen loss, however, may be 400-450 lb/ac, possibly due to suppression of nitrogen-fixing legumes (Maxwell, appendix B).

Underburns every 5-7 years have insignificant effects on biota and soil structure. Organic matter increases by about 5 percent. Nitrogen loss may average 90 lb/ac for dormant season burns and 240 lb/ac for growing season burns (Maxwell, appendix B).

In grasslands, most biomass and nutrients are below ground. Nutrient loss is less significant than in forests. Annual grassland burns, however, pose high risks to soil productivity via reduced litter biota, impaired soil porosity and infiltration, and reduced organic matter. Risks are minimal for 3-7 year frequencies (Maxwell, appendix B).

Soil Erosion

Effects of prescribed fire on soil erosion depend on fire severity. Severe slash burns cause significant erosion, because they expose mineral soil on much of the area and recovery may take 3 years. Moderate burns cause minor erosion, because they expose soil on less than 10 percent of the area and recovery usually takes 1 year. Light burns cause no erosion because they expose almost no soil (Dissmeyer and Stump 1978). Underburns and grassland burns are usually light to moderate, so their effect on erosion is negligible. Because recovery takes only 1 year, only annual burns cause chronic increases in soil loss.

Potential erosion is estimated by the Universal Soil Loss Equation (USLE). USLE computes erosion as a function of rainfall energy, soil erodibility, slope length and steepness, and ground cover (Dissmeyer and Foster 1984). Average values of rainfall, soil, and slope factors for the various landtypes are shown in table IV-12.

Table IV-12.--Average values of USLE factors for the landtypes

Landtype	Slope Steepness (Percent)	Slope Length (Feet)	USLE Factors: Rainfall	Soil Erodibility	Slope/ Length
COASTAL PLAIN					
Cross Timbers	5	200	275	0.24	0.76
Clay Prairies	3	100	300	0.34	0.29
Upper Hills	10	180	275	0.24	1.85
Rolling Uplands	5	100	425	0.24	0.54
Clay Lowlands	3	80	360	0.32	0.27
Loess Uplands	10	110	350	0.37	1.40
Miss. Valley	1	100	350	0.37	0.13
Gulf Flatwoods	1	200	500	0.20	0.16
Atlantic Flatwoods	1	200	350	0.24	0.16
Sand Ridges	3	200	375	0.17	0.35
PIEDMONT	15	110	260	0.32	2.70

Effects of fire on ground cover were inferred from 9,000 field observations in the South (Dissmeyer and Stump 1978) as modified by erosion research (Blackburn and others 1986; Brender and Cooper 1968; Cushwa and others 1971; Douglass and Van Lear 1983; Goebel and others 1967; Miller 1984; Ursic 1969, Ursic 1970). USLE's cover factor is assumed to be 0.000 for light burns, 0.002 for moderate burns, and 0.015 for severe burns. Potential erosion in the various landtypes (Maxwell, appendix B) is shown in table IV-13.

Nutrient Leaching

Leaching losses from prescribed fire depend on fire severity. Nitrogen is often mobilized in the topsoil after fire by infiltration and fixation. Some is leached through the soil and into streams. Losses of nitrogen may be 1 lb/ac for light burns, 3 lb/ac for moderate burns, and 20 lb/ac for severe burns. Losses of other, less mobile nutrients are negligible. Underburns do not cause significant leaching losses because nutrients are retained through uptake by unburned plants (Maxwell, appendix B).

Long-term Effects

Nitrogen budgets (table IV-14) show that timber harvest followed by light slash burns produces positive nitrogen budgets and allows long-term nitrogen buildup. Moderate burns produce neutral nitrogen budgets. Severe burns produce negative nitrogen budgets and cause long-term nitrogen depletion, producing losses over one timber rotation amounting to 21 percent of site total in depleted soils, 16 percent in poor soils, and 14 percent in rich soils.

Table IV-13.--Potential erosion (tons per acre) for treatments by landtype

Landtype	Mod. Burns Herbicides	Chop-Shear* Biological	Severe Burns Rake-Bed	Heavy Disk
COASTAL PLAIN				
Cross Timbers	0.10	0.15	0.75	3.01
Clay Prairies	0.06	0.09	0.44	1.77
Upper Hills	0.24	0.37	1.83	7.33
Rolling Uplands	0.11	0.17	0.83	3.30
Clay Lowlands	0.06	0.09	0.47	1.87
Loess Uplands	0.36	0.54	2.72	10.88
Miss. Valley	0.03	0.05	0.25	1.01
Gulf Flatwoods	0.03	0.05	0.24	0.96
Atlantic Flatwoods	0.03	0.04	0.20	0.81
Sand Ridges	0.04	0.07	0.33	1.34
PIEDMONT: Midland Plateau	0.45	0.67	3.37	13.48

*Includes rip, scarify, pile treatments

Table IV-14.--Cumulative nitrogen budgets (lb/ac) for pine stands on 60-year rotations

	Light Burns	Moderate Burns	Severe Burns	Piling	Raking
LOSSES					
Harvested Stems	140	140	140	140	140
Slash Removal	28	55	99	99	99
Litter Removal	100	200	360	200	360
Soil Heating*	-	60-105	220-385	-	-
Soil Displacement*	-	-	-	-	200-350
Soil Erosion#	-	1	11	2	11
Leaching	61	63	80	63	70
TOTAL	329	519-564	910-1075	504	880-1030
INPUTS					
Atmospheric	300	300	300	300	300
Plant Fixation	100	100	100	20	20
Other Fixation	200	200	200	180	180
TOTAL	600	600	600	500	500
NET BUDGET					
Depleted Soils	+271	+81	-310	-4	-380
Poor Soils	+271	+60	-387	-4	-450
Rich Soils	+271	+36	-475	-4	-530

*Nitrogen lost varies with soil nitrogen content.
#Erosion values used are average values for loess uplands.

For dormant season underburns every 3-7 years, long-term nitrogen loss may be 3-5 percent of site total in poor and rich soils and 6-8 percent in depleted soils. Losses for growing season underburns every 5-7 years may be 7 percent in rich soils, 8 percent in poor soils, and 13 percent in depleted soils. Losses for growing season underburns every 3-4 years may be 12 percent in rich soils, 15 percent in poor soils, and 22 percent in depleted soils.

Overall Risks

Long-term effects on nitrogen are combined with effects on soil biota, physical properties, and organic matter to judge overall risks to soil productivity. Risks of light slash burns are minimal on all soils. Risks of moderate slash burns are minimal on rich and poor soils, and low on depleted soils where they prevent long term soil recovery. Risks of severe slash burns are extreme on depleted and poor soils, and high on rich soils.

Risks to soil productivity from underburns depend on their frequency and season. For 5-7 year underburns, risks from dormant season burns are minimal on rich and poor soils and low on depleted soils, while risks from growing season burns are low on rich and poor soils and medium on depleted soils. For 3-4 year underburns, risks from dormant season burns are minimal on rich and poor soils and low on depleted soils, where they prevent long-term soil recovery, while risks from growing season burns are medium on rich and poor soils and extreme on depleted soils. For 1-2 year underburns, risks from dormant season burns are medium on rich soils, high on poor soils, and extrme on depleted soils, while risks from growing season burns are extreme on all soils.

Mitigating Impacts

Severe burns are avoided by conducting slash burns so they do not consume all litter and duff and alter structure and color of mineral soil on more than 20 percent of the area. One way to achieve this result is to schedule slash burns soon after a soaking (0.5 inch or more) rain when soil, duff and large fuels are moist. In addition, depleted soils can be protected by not burning any area with an average litter depth of less than 1/2 inch. For 3-4 year underburns, risks to soil productivity from growing season burns can be reduced to low on rich and poor soils and high on depleted soils by alternating them with dormant season burns.

Data Gaps

Data are lacking on the effects of severe slash burns on soil in the South. Underburns have been extensively studied, but studies of slash burns have been limited to light to moderate burns. Because severe slash burns are analyzed as posing high to extreme risks to soil productivity, data on their effects are important. The Council on Environmental Quality (CEQ) has prescribed a process for evaluating incomplete and unavailable information (40 CFR 1502.22).

To provide complete information, slash burns must be studied repeatedly on an array of depleted, poor, and rich soils in the South. The burns must be strictly controlled to produce severe effects. Such a comprehensive research program would cost several hundred thousand dollars and require 10 years or more. The Forest Service views these costs as too high to justify delay of this EIS.

The CEQ regulations require that existing credible evidence be summarized and impacts be evaluated using accepted methods. Existing data on effects of slash burns on soil are summarized in Appendix B. The method used to evaluate impacts is:

1. Data on surface and soil heating were compiled from slash burns in the Pacific Northwest and Australia and chaparral burns in the Pacific Southwest. These data were adjusted for southern burning conditions.

2. Data on effects of soil heating on organic matter and nitrogen were compiled from laboratory studies and the above field studies. These relationships were applied to typical levels of organic matter and nitrogen found in depleted, poor, and rich soils in the South to estimate degree of risk to soil productivity.

2. Effects of Mechanical

Mechanical methods may affect soil productivity through nutrient displacement, soil compaction, soil erosion, and nutrient leaching. The only tools that produce significant effects are piling and raking.

Nutrient Displacement

Nutrient displacement is the movement of organic matter and nutrients offsite by dozer blades. Slash, litter and duff, and topsoil are moved into piles or windrows that occupy 5-10 percent of the site. Nutrients contained in the moved material are effectively lost to the site (Neary and others 1984). Raking moves nearly all litter and duff and up to an inch of topsoil, while piling moves only slash and some litter and duff.

Estimates of nitrogen lost by raking that moved 1 inch of topsoil range from 430 to 760 lb/ac (Neary and others 1984; Tew and others 1984; Tuttle and others 1985). Burned windrows where about 0.5 inch of soil had been moved still had nitrogen contents of 230-330 lb/ac, despite large gaseous losses caused by burning (Morris and others 1983; Pye and Vitousek 1985). Large reductions in site pools of phosphorus, potassium, calcium, and magnesium were also reported. Reductions of nitrogen in litter and duff have ranged from 75 to 95 percent (Fox and others 1986; Morris and Pritchett 1983).

Piling is estimated to move 90 percent of slash, 50 percent of litter and duff, and no soil from the site. Effects on site organic matter are minor and short term. About 300 lb/ac of nitrogen and 25 lb/ac of phosphorus might be removed.

Raking is estimated to move 90 percent of slash, litter and duff, and 0.4 inch of topsoil from the site. Major, long-term reductions of site organic matter occur. About 650-850 lb/ac of nitrogen and 35-40 lb/ac of phosphorus may be removed. Removal of potassium, calcium, and magnesium is 15-25 percent of site total.

Soil Compaction

Soil compaction is caused by the weight of machinery on the ground. It increases bulk density and decreases aeration porosity. Bulk density of undisturbed topsoil is commonly 1.00-1.20 g/cc; as it climbs to 1.40 g/cc, root growth is inhibited (Gent and Ballard 1985). Aeration porosity (soil volume in pores larger than 0.05 mm) reflects a soil's ability to store and supply air, water, and nutrients. In

undisturbed topsoil, it is commonly 20-25 percent. When it drops below 10 percent, root growth is restricted (Baver and others 1972).

Compaction is most severe in the top 3 inches of soil. It rarely occurs below 6 inches in harvest areas, can reach to 12 inches in major skid trails, and is negligible below 12 inches (Burger and others 1985). Compaction in skid trails exceeds threshold levels of bulk density (1.40 g/cc) and aeration porosity (10 percent) throughout the top 12 inches (Gent and others 1983, 1984; Gent and Morris 1986). Severe compaction in roads, skid trails, and log decks has been found to reduce volume of 3-year-old (Hatchell and others 1970) and 26-year-old pines (Perry 1964) by 50-70 percent. It may take 20 years for severely compacted soils to recover (Wells and Morris 1982).

Compaction hazard depends on soil type and moisture. Sandy soils do not have a plastic limit; they do not have enough clay to become compact at any moisture level. Even loamy and clay soils can be significantly compacted only when soil moisture exceeds their plastic limit. The plastic limit varies from soil to soil, but is exceeded more of the time in clay soils and in floodplain and toeslope soils that receive extra moisture from upslope. Compaction hazard is highest for these soils and minimal for sandy soils.

Compaction hazard also depends on ground cover and number of machine passes. Slash, litter and duff buffer the soil against vehicle pressures. Compaction increases with number of machine passes, although most is caused by the first three passes and little occurs after 10 passes. Compaction hazard is less for methods that remove little slash, litter and duff and require 1-2 passes than for those that remove much litter and duff and require several passes.

Studies of compaction by mechanical methods in the South are limited to chopping, raking, disking, and bedding. Chopping rarely increases bulk density or decreases aeration porosity (Blackburn and others 1986; DeWit and Terry 1983; Gent and otners 1983, Gent and others 1984; Gent and Morris 1986; Morris and Pritchett 1983; Pehl 1984; Slay and others 1987; Stransky 1981). Changes are limited to the 0-3-inch soil depth. Bulk density increases average less than 0.05 g/cc and never approach 1.40 g/cc. Aeration porosity declines by 0-3 percent. Compaction by mowing, ripping, shearing, and scarifying, which also remove no organic material and require only 1-2 passes, is minimal as for chopping. Ripping reduces compaction in the furrows.

Raking, which removes litter and duff and involves several passes, commonly increases bulk density and decreases aeration porosity (Blackburn and others 1986; DeWit and

Terry 1983; Gent and Morris 1986; Morris and Pritchett 1983; Pehl 1984; Slay and others 1987; Stransky 1981; Tuttle and others 1985). Changes are limited to the 0-3 inch soil depth. Bulk density increases average 0.15 g/cc and may reach 1.40 g/cc. Aeration porosity decreases by 5-6 percent and may drop below 10 percent.

Disking restores bulk density and aeration porosity in the 0-3 inch soil depth (Gent and others 1984). It should effectively mitigate the shallow compaction caused by harvest and site preparation. Disking to at least 12 inches is required to mitigate the deep compaction on skid trails (Hatchell 1981).

Bedding restores bulk densities and aeration porosities in the beds (DeWit and Terry 1983; Gent and others 1983). It should effectively mitigate the shallow compaction caused by harvest and site preparation. Beds must be at least 12 inches high to mitigate the deep compaction on skid trails (Hatchell 1981; Gent and others 1983).

Harvest may increase bulk density by 0.10 g/cc and decrease aeration porosity by 3-5 percent in the 0-3 inch soil depth (Gent and others 1983, 1984; Gent and Morris 1986). Mowing, chopping, ripping, shearing, and scarifying are assumed to increase bulk density by 0.03 g/cc and decrease aeration porosity by 2 percent. Piling, which removes most slash and some litter and duff, is assumed to increase bulk density by 0.10 g/cc and decrease aeration porosity by 4 percent. Raking, which removes all slash, litter and duff, is assumed to increase bulk density by 0.15 g/cc and decrease aeration porosity by 6 percent. Given pre-harvest values of 1.00-1.20 g/cc for bulk density and 20-25 percent for aeration porosity, risks of exceeding threshold bulk density or aeration porosity are minimal for mowing, chopping, ripping, shearing, and scarifying, low for piling, and medium for raking. Disking and bedding effectively mitigate compaction from harvest and site preparation.

Mitigation measures do not allow heavy equipment on loamy or clay soils when the water table is within 12 inches of the surface or when soil moisture exceeds the plastic limit. This mitigation measure reduces risks from compaction in harvest areas to minimal for piling and low for raking.

Soil Erosion

As with prescribed fire, the effect of mechanical methods on ground cover was inferred from Dissmeyer and Stump (1978) as modified by erosion research (Beasley 1979; Beasley and Granillo 1985a, 1985b; Beasley and others 1986; Blackburn and others 1986; Blackburn and others 1987; Douglass and Goodwin 1980; Pye and Vitousek 1985). USLE's cover factor is 0.002 for mowing, 0.003 for chopping, scarifying, ripping, shearing, and piling, 0.015 for raking and bedding,

and 0.060 for disking. Raking, bedding, and disking require 3 years for recovery, while the other techniques require only 1 year. Disking causes the most erosion because it exposes and tills the most mineral soil. Potential erosion is shown in table IV-13.

Nutrient Leaching

Leaching losses from mechanical methods increase with degree of site disturbance (Blackburn and others 1985; Fox and others 1986; Hollis and others 1978; Morris and others 1983; Riekerk 1983; Vitousek and Matson 1984). Potential nitrogen losses may be 3 lb/ac for chopping, scarifying, ripping, shearing, and piling, 10 lb/ac for raking, and 20 lb/ac for disking and bedding. Losses of other, less mobile nutrients are negligible.

Long-term Effects

Nitrogen budgets (table IV-14) show that timber harvest followed by piling produce neutral nitrogen budgets. Raking produces negative nitrogen budgets and causes long-term nitrogen depletion. Losses over one timber rotation amount to 25 percent of site total in depleted soils, 18 percent in poor soils, and 15 percent in rich soils. Nitrogen losses from other tools are insignificant.

Overall Risks

Effects on nutrient pools and soil compaction are combined to judge overall risks to soil productivity from mechanical methods. Risks are minimal for mowing, chopping, ripping, shearing, scarifying, bedding, and disking. Risks of piling are minimal on rich and poor soils, and low on depleted soils where they prevent long-term soil recovery. Risks of raking are extreme on depleted and poor soils and high on rich soils.

3. Effects of Herbicides

Effects of herbicides on soil are summarized by Neary and Michael (appendix C). Herbicides addressed in this EIS have no effect on soil physical and chemical properties. Herbicides may affect soil productivity through biotic impacts, soil erosion, and nutrient leaching.

Biotic Impacts

Depending on application rate and soil environment herbicides can stimulate or inhibit soil organisms. Adverse effects are observed only at concentrations well above those found in forestry field studies. Herbicide use at typical forestry rates should not significantly reduce the activity of soil biota (Greaves and Malkoney 1980; Fletcher and Friedman 1986).

Soil Erosion

Herbicides do not disturb soil, so treated areas usually have intact litter and duff that maintain erosion at low levels (Neary and Michael, appendix C). USLE's cover factor is assumed to be 0.002 with recovery taking 1 year.

Potential erosion is shown in table IV-13. Tebuthiuron is an exception to this rule. Its high potency and persistence retard regrowth of non-grassy plants and interrupt litter cycling for several years (Elanco 1986). On erodible sites not having abundant grass cover, use of tebuthiuron can significantly increase risks of erosion.

Pye and Vitousek (1985) found that applying herbicides after piling and disking produced 2.6 times the erosion of piling and disking alone. They felt that suppression of invading vegetation caused the increased erosion. This effect was not noted after chopping, where litter and duff remained essentially intact. Applying herbicides after raking, bedding, or disking, which expose mineral soil over most of the area and rely on revegetation to mitigate erosion, should at least double erosion from these practices.

Nutrient Leaching

Nutrient leaching after herbicide use has been little studied. Based on nitrate losses found by Neary and others (1983), nitrogen losses are less than 10 lb/ac due to suppression of vegetation uptake. Losses of other, less mobile nutrients are negligible.

Overall Risks

Nitrogen losses from erosion and leaching do not exceed 10 lb/ac. Nitrogen budgets over a timber rotation are positive and allow long-term nitrogen buildup. Overall risks to soil productivity from herbicides are minimal.

4. Effects of Biological

Grazing can affect soil compaction, erosion, and nutrients. Degree of impact varies mostly with intensity of grazing.

Soil Compaction

Compaction hazard from grazing depends on soil type and moisture, ground cover, and grazing intensity. Light to moderate grazing increases bulk density of topsoil by

0.05-0.08 g/cc, and 1.40 g/cc is not approached. Aeration porosity declines by 0-4 percent. Heavy grazing (overgrazing) increases bulk density by 0.10-0.25 g/cc, often beyond 1.40 g/cc. Aeration porosity declines by 8-15 percent and may drop below 10 percent. Removing livestock rectifies effects of overgrazing within 3 years (Blackburn 1984; Patric and Helvey 1986; Wood and others 1987).

Harvest may increase bulk density by 0.10 g/cc and decrease aeration porosity by 3-5 percent in topsoil. Given pre-harvest values of 1.00-1.20 g/cc for bulk density and 20-25 percent for aeration porosity, risks from post-harvest grazing of exceeding threshold bulk density (1.40 g/cc) or aeration porosity (10 percent) are minimal for light to moderate grazing and high for overgrazing. Biological control requires heavy grazing, so risks to soil productivity from compaction are high.

Soil Erosion

Erosion rates from grazed land in the East range from 0.01 to 1.01 tons/ac/yr, but seldom exceed 0.30 tons/ac/yr with light to moderate grazing (Patric and Helvey 1986). In Texas grasslands, bare soil after 28 years of grazing was 0-3 percent for light grazing, 6 percent for moderate grazing, and 25 percent for heavy grazing (Blackburn 1984). In Louisiana rolling uplands, moderate grazing increased erosion on plots from 0.05 to 0.07 tons/ac (Wood and others 1987).

The effect of grazing on ground cover was inferred from Dissmeyer and Stump (1978). USLE's cover factor is given a value of 0.003. Potential erosion is shown in table IV-13.

Soil Nutrients

Moderate grazing may slightly increase nitrogen and phosphorus in topsoil (Wood and others 1987). Nutrient leaching from grazing in the South has not been studied. Nitrogen losses are assumed to be near those for raking (10 lb/ac). Losses of other, less mobile nutrients are negligible.

Nitrogen losses from erosion and leaching total about 10-15 lb/ac. Nitrogen budgets over a timber rotation are positive and allow long-term nitrogen buildup. The impact of biological methods on soil nutrients is minimal.

5. Effects of Manual

Effects of manual methods on soil are negligible. Litter and duff are left intact and revegetation is not suppresed. Risks of physical, chemical, or biological changes are minimal.

G. WATER

Introduction

Water quantity and quality can be changed by actions on the land. A key water quantity concern is the size and frequency of stormflows. Water quality is the physical, chemical, and biological purity of water. Even in undisturbed forests, floods occur and water is never pure. Concerns arise when channel stability, aquatic habitat, or water use are impaired.

1. Effects of Herbicides

Herbicides applied to the land may unintentionally enter surface or ground water. Herbicide use may also produce minor increases in stream nutrients, stormflows, and sediment yields.

Surface Water

Entry of herbicides into surface water is discussed in the Risk Assessment (appendix A) and by Neary and Michael (appendix C). Herbicides may enter streams during treatment through direct application or drift, or after treatment through surface or subsurface runoff. To pollute the water, they must then move downstream at concentrations high enough to impair water quality at a point of use.

Direct application of herbicides to surface water occurs when streams are accidently overflown during aerial application. Risks of direct application are highest in corridor maintenance because the linear flight path crosses many streams. Peak concentrations depend mostly on application rate and degree of overflight, and have commonly been 2.100 to 2.400 ppm in field studies where overflight was substantial.

Drift of herbicides into surface water depends mostly on application method, existence of buffers, and weather. Drift potential is least for ground applied pellets and greatest for aerially applied fine droplets. Buffers reduce drift potential while wind increases it. Peak concentrations from aerial spraying of fine droplets with 50-70 foot buffers have commonly been 0.130 to 0.148 ppm in field studies. Mitigation measures require buffers of 100 feet (aerial) and 30 feet (ground) and nozzles producing large droplets, so peak concentrations from aerial drift should rarely exceed 0.050 ppm (appendix A).

After treatment, herbicides may enter streams by subsurface flow or by movement in ephemeral channels. Key factors affecting peak concentration are presence of buffers, storm size, herbicide properties, and downstream mixing and dilution.

Perennial and intermittent streams are protected by 30-foot (ground) and 100-foot (aerial) buffers. Herbicides applied along these streams must move through the buffer in subsurface stormflow and are subject to dilution and mixing in transit. Ephemeral streams often do not have buffers. Herbicides applied directly to them are usually picked up in streamflow by the first storm large enough to create flow in the channels.

Large storms rarely produce high concentrations because herbicides are diluted by large water volumes. Small storms may not produce enough flow to move herbicides into streams. Intermediate storms produce higher concentrations.

Herbicide mobility and persistence greatly affect potential entry to streams. Herbicide mobility depends mainly on water solubility and adsorption (soil bonding) tendency. The potentially most mobile herbicides are 2,4-D (extreme solubility, low adsorption), picloram (high solubility, low adsorption), and hexazinone (moderate solubility, minimal adsorption). On the other hand, 2,4-DP, sulfometuron methyl, and triclopyr have minimal solubility, and fosamine and glyphosate are extremely adsorptive.

Herbicide persistence depends largely on modes and rates of degradation. Tebuthuiron is extremely persistent (half-life 392 days), because it degrades only by slow microbial action. Picloram and glyphosate are moderately persistent (half-life 60-65 days). Picloram degrades mainly by direct sunlight, and microbial degradation is slow. Glyphosate degrades mainly by microbial action but not by sunlight. On the other hand, persistence of 2,4-DP, fosamine, and sulfometuron methyl is minimal (half-life 10 days), due mainly to rapid microbial degradation.

Herbicide properties suggest that those with the most potential for subsurface movement to streams through buffers are 2,4-D, picloram, and, to a lesser extent, hexazinone. In field studies where these herbicides were applied at typical rates using typical buffer widths, peak concentrations have been less than 0.040 ppm. Despite its extreme persistence, tebuthiuron has only moderate potential for movement to streams due to its low solubility and moderate adsorption. Glyphosate has low potential because its moderate persistence is more than offset by its extreme adsorption.

Movement in ephemeral channels is little affected by herbicide mobility, because buffers are seldom used and herbicides may be applied directly to the channel. Persistence is important because it determines how much herbicide is still present in the channel when the next flow-producing storm occurs. Herbicides can be mobilized in solution or with sediment. Peak concentrations in field studies have ranged from 0.180 to 0.550 ppm.

Dilution and mixing sharply reduce herbicide concentrations downstream through water inflow and turbulence. As watershed size doubles, peak herbicide concentration should drop to 1/4 its initial level (Neary and others 1983). For example, a peak concentration of 0.400 ppm in an unprotected ephemeral stream with a 10-acre watershed will likely drop to 0.040 ppm by the time it reaches a perennial stream with a 50-acre watershed.

Mitigation measures require buffers along perennial and intermittent streams, and mixing and dilution sharply reduce

concentrations delivered by ephemeral streams. Normal application at typical rates may produce sporadic peak concentrations of some herbicides in small, headwater perennial streams. These concentrations may range up to 0.040-0.050 ppm in some cases. Even applying EPA's most stringent drinking water standard (0.100 ppm for 2,4-D) across the board, these concentrations pose minimal risks to water quality for public health or aquatic biota. Risks from accidental direct application may be high on some corridor maintenance projects treated aerially. Since picloram affects many vegetable crops at concentrations as low as 0.010 ppm (Baur and others 1972), it should be used with care near water used for irrigation.

Ground Water

Entry of herbicides into ground water is discussed in the Risk Assessment (appendix A) and by Neary and Michael (appendix C). After treatment, herbicides may move into aquifers by vertical seepage. To pollute ground water, they must then move laterally at concentrations high enough to impair water quality at a point of use. Key factors affecting peak concentration are herbicide properties, soil type, depth to water table, and distance to point of use.

Herbicide mobility and persistence greatly affect potential for seepage. Mobility depends on solubility and adsorption and persistence depends on degradation mode and rate. As discussed earlier, the potentially most mobile herbicides are 2,4-D, picloram, and hexazinone, and the most persistent ones are tebuthiuron, picloram, and glyphosate. Mobility and persistence properties suggest that herbicides with at least a moderate seepage potential include 2,4,-D, dicamba, hexazinone, imazapyr, picloram, and tebuthiuron.

Herbicides move most easily through sands, which are most porous and have the least adsorption potential. Potential for ground water contamination increases as depth to water table and distance to point of use decrease.

Weeks and others (appendix A) modeled herbicide contamination of ground water under conditions likely to produce high concentrations. Herbicides were applied at maximum rates to the soil surface. They were then leached through 3 feet of sandy loam soil by 50-60 inches of annual rainfall. The water table was only 3 feet deep, and the aquifer was sand. In the model, only dicamba, hexazinone, imazapyr, picloram, and tebuthiuron reached the water table even 10 percent of the time. Concentrations in ground water directly under the treated area exceeded 0.001 ppm only for hexazinone (0.004), dicamba (0.005), and tebuthiuron (0.008). Only tebuthiuron, with its 392-day half-life, moved outside the treatment area; maximum concentration at 330 feet was 0.002 ppm 1 year after treatment.

Field studies of herbicides applied at typical rates showed that sulfometuron methyl and triclopyr did not seep to shallow ground water, and hexazinone reached peaks of less than 0.024 ppm. Applied at typical rates, picloram concentrations in shallow ground water should be less than 0.002 ppm (Neary and Michael, appendix C).

Applied at typical rates, herbicides should never occur in ground water supplies at concentrations exceeding a small fraction of EPA's most stringent drinking water standard. Risks of impaired ground water quality are minimal, especially since mitigation measures require a 100-foot buffer around all water sources that reduces herbicide concentrations through mixing and dilution.

Stream Nutrients

Broadcast use of herbicides may produce minor increases in stream nutrients such as nitrates. Increases are short-lived due to minimal soil disturbance and prompt regrowth. Drinking water standards are not exceeded if mitigation measures are employed (Neary and others 1986).

Stormflows

Effects of herbicides on stormflows have not been directly measured. Increases should be minor because soil infiltration capacity is generally maintained. Target-specific application does not increase stormflows because plant water use is little affected. Broadcast application may produce small increases by reducing plant water use (Neary and others 1986).

Tebuthiuron may produce larger increases. Its high potency and persistence retard regrowth of non-grassy plants and interrupts litter cycling for several years (Elanco 1986). Bare soil and surface runoff may increase significantly.

Sediment Loads

Sediment is produced by surface and channel erosion. Surface erosion is minimal in undisturbed forests and is caused by soil exposure and tillage. Channel erosion occurs even in undisturbed forests and increases with peak flows.

Potential surface erosion is shown in Table IV-13. Only a fraction of surface erosion becomes sediment. This fraction (sediment delivery ratio) increases with steeper slopes and denser drainage networks and is reduced by buffers along streams. Because perennial and intermittent streams are protected by buffers, eroded soil is delivered almost solely to ephemeral streams. Data on average slope steepness and drainage density were used to derive sediment delivery ratios (appendix B) and sediment yields from surface erosion for the various landtypes (Table IV-15).

Data isolating channel-eroded sediment from surface-eroded sediment are scarce. Channel sediment increases with peak flow. Increases from broadcast herbicide application should be small.

Table IV-15.--Sediment delivery ratios and sediment yields for treatments by landtype

Landtype	Sediment Delivery Ratio	Sediment Yield (tons/acre) Mod. Burns Herbicides	Chop-Shear* Biological	Severe Burns Rake-Bed	Heavy Disk
COASTAL PLAIN					
Cross Timbers	.03	.0030	.0045	.0225	.0903
Clay Prairies	.01	.0006	.0009	.0044	.0177
Upper Hills	.05	.0120	.0185	.0915	.3665
Rolling Uplands	.03	.0033	.0051	.0249	.0990
Clay Lowlands	.01	.0006	.0009	.0047	.0187
Loess Uplands	.05	.0180	.0270	.1360	.5440
Miss. Valley	.01	.0003	.0005	.0025	.0101
Gulf Flatwoods	.01	.0003	.0005	.0024	.0096
Atlantic Flatwoods	.01	.0003	.0004	.0020	.0081
Sand Ridges	.01	.0004	.0007	.0033	.0134
PIEDMONT: Midland Plateau	.06	.0270	.0402	.2022	.8088

*Includes rip, scarify, pile treatments

2. Effects of Mechanical

Mechanical methods may increase stream nutrients, stormflows, and sediment loads. In general, amount of increase depends on degree of disturbance, topography, and soil type.

Stream Nutrients

Mechanical methods may increase stream concentrations of some nutrients. Drinking water standards are not exceeded if mitigation measures are employed (Fox and others 1986; Hewlett 1979; Hollis and others 1978; Riekerk 1985).

Stormflows

Mechanical methods can increase stormflow volumes and peaks in small (1-12 acre) watersheds. Ripping and scarifying produce no increases because soil disturbance is offset by increased surface storage (Miller 1984). Chopping, shearing, piling, and bedding retain soil infiltration capacity and produce small increases by reducing water use by vegetation. Typical increases in stormflow volumes and peaks are 40 percent for these four tools, and they last one year. Disking and raking produce larger increases by reducing infiltration and promoting surface runoff. Typical increases are 200 percent and may last three years or more (Beasley and Granillo 1985; Blackburn and others 1986,1987; Douglass and others 1983; Swindel and others 1983a, 1983b; Ursic 1986).

Sediment Loads

Mechanical methods can increase sediment loads from both surface and channel erosion in small (1-12 acre) watersheds. Amount of increase is related to degree of

disturbance (Beasley 1979; Beasley and Granillo 1985a,1985b; Beasley and others 1986; Blackburn and others 1986,1987; Douglass and Goodwin 1980; Ursic 1986).

Sediment delivery ratios were applied to erosion rates to derive sediment yield from surface erosion for the various landtypes (Table IV-15). Channel sediment tends to increase in proportion to peak flow.

3. Effects of Prescribed Fire

Prescribed fire may increase stream nutrients, stormflows, and sediment loads. In general, amount of increase depends on fire severity.

Stream Nutrients

Slash burns may produce minor increases in concentrations of some nitrogen compounds and cations, but drinking water standards are not exceeded even by severe burns. Underburns and grassland burns have no significant effect (Maxwell, appendix B).

Stormflows

Moderate slash burns may increase stormflow volumes and peaks by reducing water use by remaining vegetation. Severe burns cause greater increases by exposing mineral soil and promoting surface runoff (Maxwell, appendix B).

Underburns and grassland burns are light to moderate. Underburns do not affect water use, and grassland burns only affect it for a few weeks until grass regrows. These burns do not significantly affect stormflows (Maxwell, appendix B).

Sediment Loads

Sediment delivery ratios were applied to erosion rates to derive sediment yield from surface erosion for the various landtypes (Table IV-15). Channel sediment increases in proportion to peak flow.

4. Effects of Biological

Grazing minimally increases stream concentrations of nutrients. Livestock with access to streams increase harmful bacteria in the water, which drop to base levels within a few days of livestock removal. When not deposited near channels, animal wastes are processed by litter, duff, and soil (Patric and Helvey 1986). Mitigation measures require livestock to be managed to prevent water contamination and streambank damage, so risks to public health are minimal.

Light to moderate grazing commonly reduces soil infiltration capacity by less than 50 percent. Heavy grazing reduces it by 50-90 percent (Blackburn 1984; Patric and Helvey 1986; Wood and others 1987), but it is still sufficient to handle all but the most intense rainstorms (Patric and Helvey 1986). In Oklahoma and Texas grasslands, 20-30 years of continuous overgrazing increased runoff by more than 100 percent and sediment yield by 10-26 times above moderate rotation grazing (Blackburn 1984).

Heavy grazing increases stormflows by reducing soil infiltration capacity and plant water use. Sediment delivery ratios were applied to erosion rates from table IV-13 to derive sediment yield from surface erosion for the various landtypes (table IV-15). Channel sediment increases in proportion to peak flow.

5. Effects of Manual

Manual methods do not increase peak flows because plant water use is little affected. Stream nutrients and sediment loads are not increased because litter and duff are left intact and revegetation is not suppressed.

6. Watershed Analysis

Cumulative effects on water include the combined effects of vegetation management and timber harvest onsite, plus those of all other management on all other lands in a watershed. All these effects must be integrated and compared with tolerance limits for the watershed. Cumulative effects on water are increased herbicide concentrations, stormflows, and sediment loads.

Cumulative effects were analyzed on typical watersheds in the Coastal Plain/Piedmont. Two large (20,000+ acre) watersheds were used to assess cumulative effects dominated by private management. Eight small (4,400-8,500 acre) watersheds that represent the array of landtypes were used to assess cumulative effects dominated by Forest Service management (Table IV-16).

Table IV-16.--Land use data for typical watersheds, cumulative water effects

Watershed	Landtype	National Forest	Total Acres	N.F. Acres	-----Private Acres----- Timber	Crop	Pasture
BRUSHY CK.	COASTAL PLAIN	Homochitto	23,860	16,240	6,900	290	430
Payne L.	Upper Hills	Talladega	7,890	7,810	80	0	0
Cottonwood Ck.	Grasslands	LBJ	8,500	5,100	170	80	3,150
Hager Ck.	Rolling Uplands	Davy Crockett	5,200	3,600	1,080	50	470
Red Prong	Loess Uplands	Homochitto	4,700	3,660	950	0	90
Buck Br.	Clay Lowlands	Bienville	8,110	7,020	770	160	160
Ninemile Ck.	Sand Ridges	Ocala	4,400	4,190	210	0	0
Two Barrel Br.	Flatwoods	Apalachicola	4,600	4,520	80	0	0
INDIAN CK	PIEDMONT	Sumter	54,600	30,800	14,280	4,760	4,760
Patterson Ck.	Midland Plateau	Sumter	6,400	5,500	600	200	100

Cumulative effects are most rigorously analyzed on the 8 small watersheds. Forest Service land makes up most of their area and downstream mixing and dilution are limited. They were chosen to represent significant differences in topography, earth materials, and runoff-erosion response to management. Figure IV-3 shows the landtypes in the Coastal Plain/Piedmont.

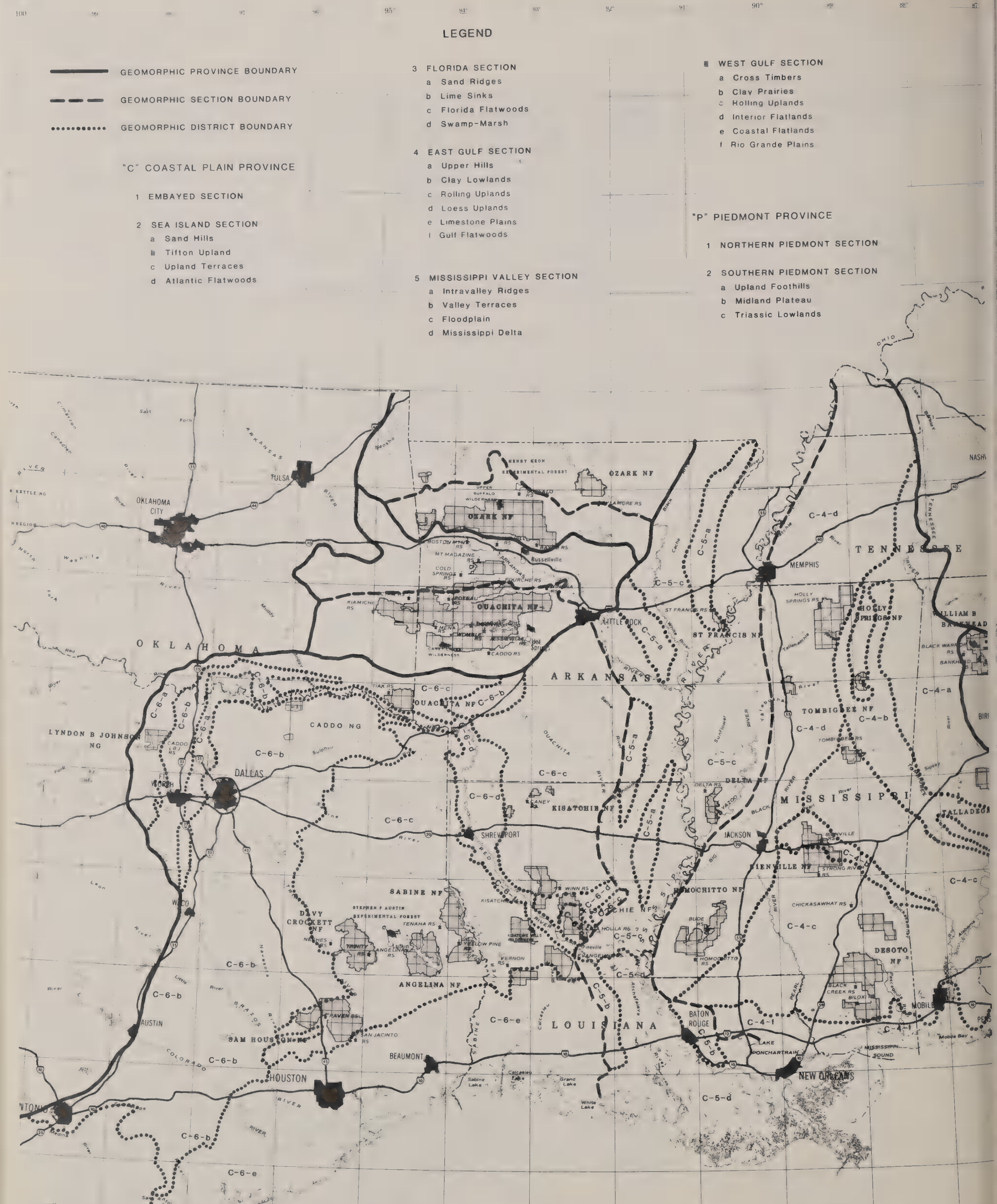


Figure IV-3.--Landtypes of the Coastal Plain/Piedmont

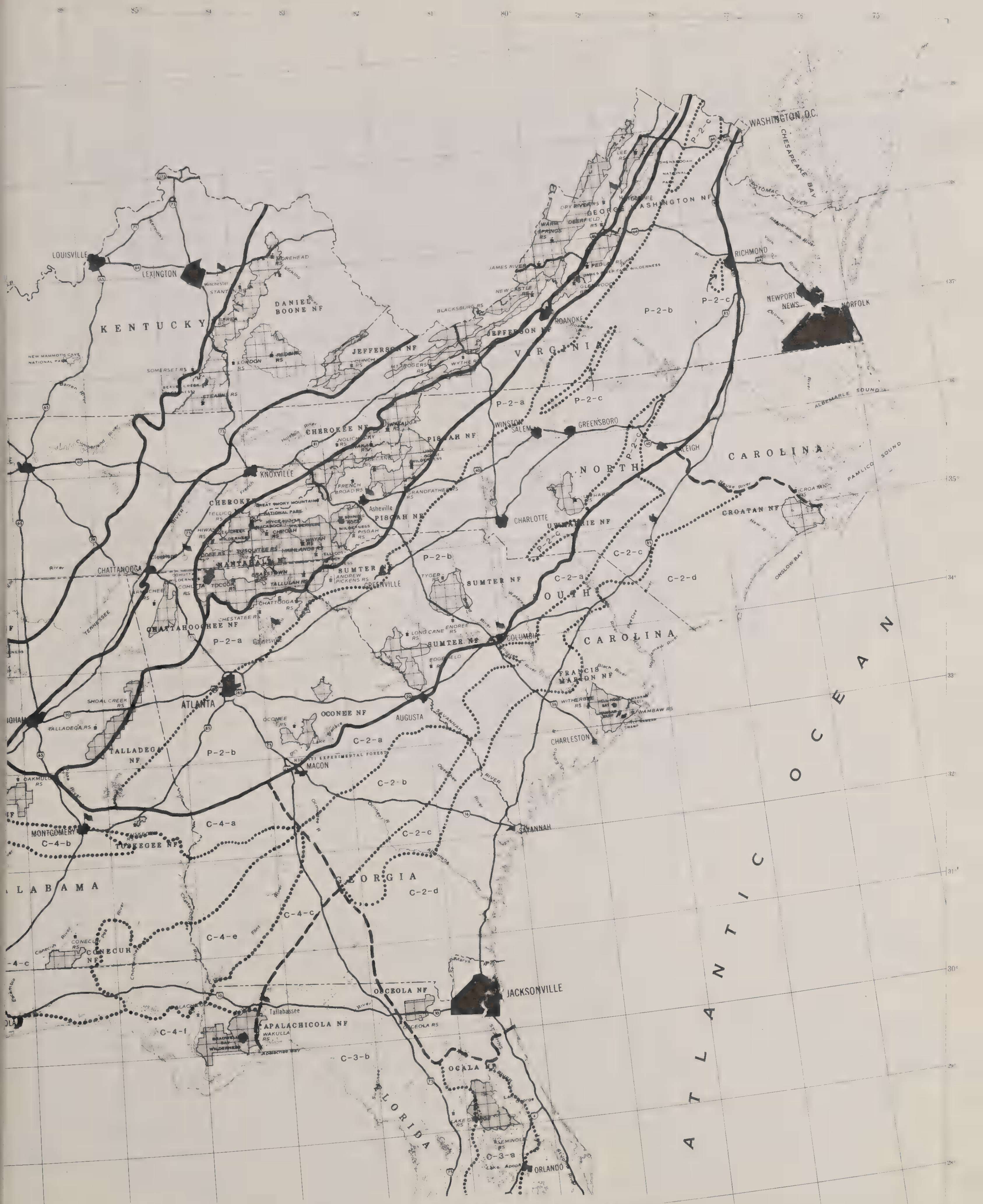


Figure IV-3.--Landtypes of the Coastal Plain/Piedmont (continued)

Herbicide Concentrations

Herbicides used on national forests are applied at low rates, separated from perennial and intermittent streams by buffers, and subject to considerable downstream mixing and dilution. In the maximum herbicide alternatives (G and H), assuming all eligible acres are treated in the same year, less than 10 percent of the watershed is herbicide-treated on national forest land in every watershed except Hager Creek (17 percent) and Ninemile Creek (11 percent). Maximum herbicide concentrations due to national forest use at the mouth of the watersheds should never exceed 0.020 ppm unless herbicides are accidently applied directly to surface water.

Herbicides used on farmland are usually applied every year, at high rates, and along perennial streams. Peak concentrations measured in runoff range from 1.800 to 5.200 ppm (Wauchope 1978). Considered alone or in addition to other management, risks to water quality from typical application on Forest Service land are minimal.

Stormflows

Timber harvest increases stormflow volumes and peaks in proportion to percent of stems cut. Increases from clearcuts in 1-3 acre watersheds average 40 percent for 1 year (Douglass and others 1983; Ursic 1970). Additional first year increases are: 40 percent for broadcast herbicides, chopping, shearing, piling, bedding, grazing, and moderate slash burns; and 200 percent for disking, raking, and severe slash burns. Stormflow peaks are subject to considerable flattening downstream from turbulence and dilution. In the maximum treatment alternative (H), stormflow increases at the mouth of the watersheds due to national forest management are 2-7 percent except for Hager Creek (20 percent). Adding the effects of private land management, stormflow increases range from 3 to 33 percent. This analysis assumes that maximum rates of timber harvest are used, all eligible acres are treated in the same year, and stormflows from national forest and private lands are synchronized. These increases represent average-sized stormflows. Increases during large floods, which occur when soils over the entire watershed are saturated, would be much less.

Sediment Loads

Channel erosion occurs even in undisturbed forests, and is generally lowest in the level channels of the Lower Coastal Plain and highest in the steeper, erodible channels of the loess uplands (Ursic 1986). It increases in proportion to peak flow. In this analysis, clearcuts are estimated to increase channel sediment an average of 40 percent for 1 year. Additional increases are estimated to be: 40 percent for broadcast herbicides, chopping, shearing, piling, bedding, grazing, and moderate slash burns; and 200 percent for disking, raking, and severe slash burns. Increases in channel sediment are estimated at 40 percent for pasture land and 200 percent for cropland.

In addition to vegetation management, surface-eroded sediment is increased by timber harvest, agricultural use, and roads. Typical rates of surface erosion for these uses were combined with sediment delivery ratios for the various landtypes to estimate surface-eroded sediment. Estimates of channel and surface sediment were combined to derive total 10-year sediment yield for each watershed (Table IV-17). Maximum rates of timber harvest were assumed and Alternative H was modeled to show the greatest possible effect.

A chief concern of increased sediment is its effect on quality of fish habitat. Risks to habitat quality are minimal for increases of 0-100 percent, low for 100-200 percent, medium for 200-300 percent, high for 300-400 percent, and extreme for increases greater than 400 percent (Alexander and Hansen 1986).

Table IV-17 shows that for all watersheds in the Coastal Plain, risks to fish habitat quality from sediment are minimal. Increases are especially small on watersheds with little private land or with flat topography.

In the Piedmont, risks are low on the small watershed and high on the large watershed. In both cases, half of the sediment increase comes from private cropland, where rate of surface erosion is estimated as 4.5 tons per acre per year. Sediment from vegetation management is only 1-3 percent of the total increase and does not increase risks to fish habitat.

7. Data Gaps

Data are lacking that isolate effects of vegetation management on channel sediment in the Coastal Plain/Piedmont. Effects on stormflows have been studied, but increases in channel sediment have not been isolated from surface-eroded sediment. Because channel sediment makes up a significant share of total sediment load, data on how management affects it are important. The Council on Environmental Quality (CEQ) has prescribed a process for evaluating incomplete and unavailable information (40 CFR 1502.22).

To provide complete information, timber harvest and vegetation management activities must be studied on an array of landtypes in the South. Studies must be strictly controlled to isolate channel sediment due to increased stormflows from sediment due to surface erosion. Such a research program would be very difficult to implement, would cost several hundred thousand dollars, and would require 10 years or more. The Forest Service views these costs as too high to justify delay of this EIS.

Table IV-17.—Cumulative 10-year sediment yields (tons) for typical watersheds

		BRUSHY	Payne	Cottonwood	Hager	Red Prong	Buck	Ninemile	Two Barrel	INDIAN	Patterson
NATURAL		14,316	1,578	1,700	1,040	2,820	811	440	460	10,920	1,280
USFS:	Roads	106	38	14	36	87	16	9	7	4,700	436
	Harvest	269	21	230	31	42	4	4	4	293	35
		375	59	244	67	129	20	13	11	4,993	471
PVT:	Roads	424	12	17	91	24	6	1	2	2,218	144
	Forest	3,500	51	28	97	487	7	3	2	9,005	378
	Cropland	1,469	0	78	52	0	58	0	0	27,948	1,174
	Pasture	674	0	726	153	141	19	0	0	8,461	178
		6,067	63	849	393	652	90	4	4	47,632	1,874
ALT. H		413	27	10	75	64	10	8	9	544	65
TOTAL INCREASE		6,855	149	1,103	535	845	120	25	24	53,169	2,410
PERCENT INCREASE		(48)	(9)	(65)	(51)	(30)	(15)	(6)	(5)	(487)	(188)

CEQ regulations require that existing credible evidence be summarized and impacts be evaluated using accepted methods. Existing studies where surface erosion was essentially absent suggest that channel sediment increases roughly in proportion to peak flow. The processes involved are well understood but complex, so we have expressed percent increase in channel sediment as equal to percent increase in peak flow for ease of explanation. For example, chopping increases peak flow an average of 40 percent and is therefore estimated to increase channel sediment by 40 percent.

H. AIR QUALITY

Air is a dynamic resource whose quality fluctuates over time and space. Key air quality concerns are concentrations of gases and particulates that may impair human health and welfare. Prescribed fire is the only vegetation management method that emits significant gases and particulates to the atmosphere. Prescribed fire presently occurs on about 10 percent of national forest lands in the Coastal Plain/Piedmont each year. On a given site, slash burns may occur once every 40-80 years, and underburns every 3-7 years. Effects on air quality are temporary and intermittent in each area affected.

Periodic fires have played an important role in the formation and maintenance of Coastal Plain/Piedmont

ecosystems (Komarek 1967; Kozlowski and Ahlgren 1974; Wade 1983). Coastal Plain pine forests are naturally fire-dependent (Braun 1950; Oosting 1956). The air quality of the region has thus been subject to the influence of wildland fires for thousands of years.

Wildfires emit the same pollutants as prescribed fires. In general, emissions from wildfires are greater per acre burned and often occur at times when winds may carry smoke directly into sensitive areas. Smoke dispersion is also impaired when wildfires burn into the night (Sandberg and Ward 1981).

Any wildland fire burns in 4 phases (McMahon 1983; National Wildfire Coordinating Group 1985; Sandberg and others 1979). During preignition, fuels ahead of the fire are heated and dried and gases are released. During flaming combustion, temperatures rise rapidly, gases are flamed, and black smoke dominated by solid soot particles is produced. During smoldering combustion, temperatures drop and gases condense to produce white smoke composed mostly of liquid tar droplets. Smoldering emits 2-5 times the particulates as flaming. During glowing combustion, all combustible gases have been driven off, no visible smoke is produced, and carbon monoxide and carbon dioxide are the chief emissions.

1. Gases

EPA considers some gases emitted by prescribed fire (carbon monoxide, hydrocarbons, nitrogen and sulfur oxides, and photochemical oxidants) to be pollutants (McMahon 1981). Emission of these gases by prescribed fire, summarized by McMahon (1983), National Wildfire Coordinating Group (1985), Sandberg and Ward (1981), Sandberg and others (1979), USDA Forest Service (1976), and Van Lear and Johnson (1983), is discussed below.

Carbon Monoxide

This colorless, odorless, toxic gas is the most abundant air pollutant from forest fires. Its adverse effect on human health depends on exposure time, level of physical exertion, and concentration of gas. Typical emission factors range from 40 lb per ton of fuel consumed during flaming, to 200 lb/ton during smoldering, to 500 lb/ton in smoldering slash piles and organic soil. Concentrations may be 100-200 ppm at the fireline but diluted to less than 10 ppm about 100 feet downwind, so public health hazards are not significant.

Hydrocarbons

Hydrocarbons contain hydrogen, carbon, and sometimes oxygen. Typical emission factors are 30-100 lb/ton of fuel consumed, with most produced during smoldering. Most hydrocarbons have no harmful effect, but several are carcinogens. Risks of developing cancer from prescribed fire are less than 1 in a million (Dost 1986).

Nitrogen Oxides	At high concentrations, these toxic gases can affect the lungs. Prescribed fires emit only minor amounts by oxidation of fuel nitrogen. Most forest fuels contain less than 1 percent nitrogen, of which 20 percent is converted to nitrogen oxides when burned. Concentrations are not high enough to affect human health.
Sulfur Oxides	Emissions of sulfur oxides are negligible because most forest fuels contain less than 0.2 percent sulfur. Emission factors for woody fuels are less than 0.4 lb/ton. Risks of adverse effects on human health are minimal.
Photochemical Oxidants	Ozone can form in the upper layer of smoke plumes exposed to sunlight. Concentrations of up to 0.1 ppm have been reached in some plumes, usually in the first hour and within 2 miles downwind. Formation of photochemical oxidants by prescribed fire is a minor problem due to its intermittent occurrence.

2. Particulate Matter

Particulate matter, a complex mixture of solid and liquid particles, make up the visible smoke seen in all fires. Particles 0.3-0.8 micron in diameter absorb and scatter light most efficiently. Those less than 10 microns in diameter can be inhaled. Those less than 2.5 microns in diameter can be breathed into the lungs. The average particle diameter in forest fire smoke is 0.1-0.3 micron; 90 percent of particles are less than 2.5 microns and nearly all are less than 5 microns (McMahon 1983; Sandberg and Ward 1981; Sandberg and others 1979; Van Lear and Johnson 1983).

Effects of particulates on air quality are analyzed here in 3 phases. Local effects are those felt near the burn. General effects are those felt over an area downwind from the burn. Regional effects are the cumulative effects of particulate emissions throughout the whole Coastal Plain/Piedmont.

Air Quality Standards

EPA has developed air quality standards for particulates to protect public health from respiratory damage and public welfare from impaired visibility and transportation hazards. The new PM_{10} standard applies to particulates less than 10 microns in diameter. It is exceeded if PM_{10} concentrations exceed an average of 150 micrograms per cubic meter (ug/m^3) for more than one 24-hour period per year, or exceed an average of 50 ug/m^3 for an entire year (Stonefield 1987).

In addition to these general air quality standards, the Clean Air Act mandates special protection for visibility in Class I areas. The basic strategy is to limit the total effect from all sources to less than a specified increase above a chosen baseline concentration. EPA may soon develop a $PM_{2.5}$ standard, for particulates less than 2.5 microns in diameter, to address this issue (Stonefield 1987).

In general, the states have responsibility for monitoring and enforcing air quality standards. National Forests must comply with state regulations as well as our own smoke management guidelines in our burning programs.

Local Effects

In the South, the major effect of smoke on air quality is reduced visibility on highways, airports, and populated areas near the fire. Particulate concentrations may meet the 24-hour standard of 150 ug/m^3 but exceed it by 10-fold or more for short periods. This problem is widely recognized, and research efforts have been organized to address it.

During flaming, smoke rises from a burn in a smoke plume. During smoldering, heat release is not enough to sustain significant plume rise so smoke stays near the ground. Such problems may worsen during inversions or in stable night air when rising humidity can cause a smoke-fog mixture to form. Use of smoke management guidelines mitigates impacts by enhancing flaming, reducing smoldering, and burning during atmospheric conditions that favor smoke dispersion (Lavdas 1986; McMahon 1983; Paul and others 1987; Petersen and Lavdas 1986; National Wildfire Coordinating Group 1985).

Flaming is enhanced by using backing and flanking fires, which move slowly enough to preheat fuels and create a more uniform flame zone to consume gases. Smoldering is reduced by burning when large fuels are moist and unavailable and small fuels are dry, by broadcast burning slash rather than in piles (or at least keeping soil out of piles), and by promptly mopping up after the burn (McMahon 1983; National Wildfire Coordinating Group 1985; Pyne 1984; Sandberg and Ward 1981).

A slightly unstable atmosphere favors smoke dispersion. Such conditions are often characterized by good visibility, cumulus clouds, clear days, steady winds, and low to moderate humidity. Burning during downslope winds or high humidities should generally be avoided (Paul and others 1987; National Wildfire Coordinating Group 1985).

General Effects

Smoke can impair general air quality in sensitive areas downwind from extensive burning activity. Use of smoke management guidelines mitigates impacts by reducing smoke emissions and burning during atmospheric conditions that favor smoke dispersion (Lavdas 1986; Petersen and Lavdas 1986; Sandberg 1983; USDA Forest Service 1976). Following is a general discussion of smoke emission and dispersion principles.

<u>SMOKE EMISSIONS</u> are a product of emission factor (pounds of particulates produced per ton of fuel consumed) and amount of fuel consumed. Emissions are reduced by increasing

combustion efficiency, which is highest during flaming and when small fuels are homogeneous, loose, and dry. Backing and flanking fires produce one-third of the smoke that heading fires do. Mass-igniting slash burns, which reduces buildup time to flaming, can reduce emissions of a fire under ideal conditions by up to 25 percent. Broadcast burning slash rather than in piles (or at least keeping soil out of piles) greatly reduces smoldering (Sandberg 1983; Sandberg and Ward 1981; Sandberg and others 1979).

Emissions are also reduced by limiting fuel consumption. Slash burning when duff and large fuels are moist and unavailable limits smoldering and can reduce emissions of a fire under ideal conditions by up to 50 percent. This strategy is accomplished by scheduling slash burns soon after a soaking (0.5 inch or more) rain. Emissions from smoldering are also reduced by promptly mopping up after a burn (National Wildfire Coordinating Group 1985; Sandberg 1983, 1985; Sandberg and Ward 1981).

<u>ATMOSPHERIC DISPERSION</u> can mitigate general effects through two smoke management strategies. "Avoidance" uses wind direction to send smoke away from sensitive areas. "Dilution" uses favorable weather conditions to reduce smoke in sensitive areas downwind (Sandberg 1983).

<u>Avoidance</u> is most appropriate for reducing impacts to nearby areas by sending smoke away from them. To be successful, variations in wind direction over time and space must be considered. Because predicting wind direction is difficult for more than 24 hours, during light winds, and at night, avoidance is not usually appropriate for long-duration fires or fires that smolder into the evening.

<u>Dilution</u> relies on mixing smoke with clean air vertically and horizontally. Atmospheric stability, mixing height, and transport windspeed govern this process (National Wildfire Coordinating Group 1985; Pyne 1984; USDA Forest Service 1976).

Atmospheric stability affects the rate of smoke dispersion. An unstable atmosphere is turbulent and rapidly mixes smoke. Slight instability usually provides adequate smoke dispersion but maintains a steady enough wind for good fire control. A neutral atmosphere may provide adequate dispersion, depending on other atmospheric factors.

Mixing height also affects rate of smoke dispersion. It is the vertical extent of unstable air, capped by an inversion or windshear layer, that allows vertical spread of a smoke plume through convection and turbulence. High mixing heights mean large volumes of air may be available for smoke dispersion. To provide adequate dispersion, mixing heights

should exceed 1,600 feet. Lower mixing heights are most common under low inversions and windshear layers, under stagnant high pressure systems, and on the cold air side of warm, stationary, or weak cold fronts. On generally clear nights with light winds when surface temperature inversions form, there is no mixing height and smoke is trapped near the ground and spreads very slowly.

Transport windspeed is the average windspeed in the layer of air likely to contain smoke. Adequate smoke dispersion requires a transport windspeed of at least 9 mph.

Combinations of atmospheric stability, mixing height, and transport windspeed needed for good smoke dispersion are most common between high and low pressure systems and behind vigorous cold fronts. The combined effects of atmospheric stability, mixing height, and transport windspeed on smoke dispersion have been expressed in a numerical rating called the "dispersion index" (Lavdas 1986).

Regional Effects

Regional effects on air quality are analyzed as the combined smoke emissions of all prescribed fires and wildfires on all lands in the Coastal Plain/Piedmont. Prescribed fire accounts for 17.4 percent of emissions from wildland fires in the area (Sandberg and others 1979). Even in alternative H, prescribed fires on national forests total 523,000 acres per year, only 10 percent of all prescribed fire acres in the area. National forest prescribed fires should thus account for less than 2 percent of smoke emissions from wildland fires (0.174 x 0.10) and have insignificant effects on regional air quality.

Secondary air quality concerns are acid deposition and the "greenhouse effect." Prescribed fires emit minute amounts of nitrogen and sulfur oxides to the atmosphere, so their impact on acid deposition is negligible. They also release calcium and magnesium to air and soil, so they may actually mitigate acid deposition (Maxwell, appendix B).

The greenhouse effect depends mostly on carbon dioxide output as affected by biomass activity. The carbon dioxide balance is upset only by massive tropical slash and burn programs that eliminate plant oxygen production and emit vast amounts of carbon dioxide on a regional scale. Effects of forestry prescribed fires are minimal.

3. Emission Estimates

Effects of the alternatives on air quality are analyzed by estimating total smoke emissions from prescribed fires and wildfires on national forests. Emissions are a product of emission factors, fuel loads, and acres burned in each of five major fuel groups:

a. Grassland--national grasslands in Texas (38,000 acres).

b. Pine-heavy brush--pine/palmetto-gallberry, sand pine, and pond pine fuel types in Florida and along Mississippi and North Carolina coasts (1,362,000 acres).

c. Pine-grass--south Alabama, southeast Mississippi, and southwest Louisiana (563,000 acres).

d. Hardwood -- Mississippi Valley (60,000 acres).

e. Pine-light brush--Piedmont and rest of Coastal Plain (2,590,000 acres).

Emission factors vary by fuel consumed and combustion mode. Available fuels include grass in grassland burns, plus litter and brush in underburns, plus tree limbs and foliage in slash burns and wildfires. Smoldering increases emission factors, which are typically 15 lb/ton for grassland burns and pine-grass underburns, 35 lb/ton for pine-heavy brush underburns, 75 lb/ton for pine-light brush underburns and slash burns, and 100 lb/ton for forest wildfires (McMahon 1983; Sandberg 1983; Southern Forestry Smoke Management Guidebook 1976; Ward 1983).

Available fuel load depends on fuel type, buildup, arrangement, and moisture content. Typical available fuel loads for underburns are 3-4 tons/ac in pine-grass and pine-light brush fuels and 4-6 tons/ac in pine-heavy brush fuels (Sackett 1975; USDA Forest Service 1976). Grassland burns consume the same amount of fuel as pine-grass underburns, but the fuel is all grass instead of a grass-litter mixture (Mutz and others 1985). Wildfires in

underburned stands consume 1 ton more than underburns because they tend to burn under drier conditions. If underburns are excluded, available fuel for wildfires can eventually build up to 8-10 tons/ac in pine-grass and pine-light brush fuels and 18-22 tons/ac in pine-heavy brush fuels (USDA Forest Service 1976).

Underburns interrupt fuel buildups, slowing the spread and aiding the control of wildfires. Excluding underburns in pine-heavy brush may increase average acres burned by wildfire by up to 100-fold (Davis and Cooper 1963). In our analysis, increases are assumed to be a conservative 10-fold.

In each alternative, the acres burned by prescribed fire and wildfire are multiplied by the emission factors and fuel loads discussed above to estimate total smoke emissions from each fuel group. Acres burned by prescribed fire and wildfire are assumed to be distributed among the fuel groups as at present. For example, suppose an alternative calls for 10,000 acres to be slash burned. Since 11.6 percent of slash-burned acres presently occur in pine-grass, then slash burns are assumed to occur on 1,160 acres of pine-grass in that alternative (10,000 x 0.116).

I. WILDFIRE

Periodic fires have played an important role in the formation and maintenance of Coastal Plain/Piedmont ecosystems. Coastal Plain pine forests are naturally fire-dependent. Prescribed fire can affect the occurrence and spread of wildfires.

1. Escaped Prescribed Fires

Prescribed fires can become wildfires when they accidentally escape their boundaries and burn non-target areas. These effects are mitigated by burning under fuel and weather conditions that promote control of fire spread. In general, escaped prescribed fires are quickly controlled, so their effects are insignificant.

2. Fuel Reduction

Underburns slow the spread and aid the control of wildfires by interrupting fuel buildup. When underburns are excluded, fire hazard increases progressively as litter accumulates, flammable understory shrubs increase in size, and needle drape develops, providing a pathway for surface fire to reach tree crowns (Wade 1983).

Unless reduced by underburns, fuels build up beneath pine stands until an equilibrium is reached between accumulation and decomposition (Wade 1983). Litter fuels reach equilibrium in 5-10 years (Sackett 1975), but time to total fuel equilibrium varies with latitude from about 20 years in north Florida to more than 25 years in Georgia and South Carolina (Wade 1983).

Available fuels in underburned stands amount to 3-6 tons per acre (USDA Forest Service 1976). If underburns are

excluded, available fuels for wildfires can build to 8-10 tons per acre in pine-grass and pine-light brush fuel groups and 18-22 tons per acre in pine-heavy brush fuel groups (Martin and others 1979; USDA Forest Service 1976). Hazards are highest in palmetto-gallberry understories, which are very flammable and can grow to six feet, forming an effective "ladder" to the canopy (USDA Forest Service 1976).

Underburns done at intervals longer than 5 years in the Coastal Plain and 7 years in the Piedmont can damage the overstory and be harder to control (Sackett 1975). Excluding underburns in pine-heavy brush may increase average acres burned by wildfire up to 100-fold (Davis and Cooper 1963). In this analysis, increases are assumed to be a very conservative 10-fold. Over time, increased recreation use of national forests should increase risk of wildfire occurrence.

Prescribed fires also decrease wildfire hazard on adjacent lands. Excluding underburns increases spread of wildfire from national forests to these lands. Over time, increased urbanization should increase wildfire hazard to people and property.

J. ROW CORRIDORS

The type, species, and amount of vegetation affect treatments needed to maintain safety and integrity of the facility occupying a right-of-way. Insufficient vegetation management reduces safety along roads, trails, railroads and powerlines; creates power outages; or increases facility maintenance costs, wildfire potential, and investment loss. Excessive vegetation manipulation or improper timing of treatments can cause accelerated soil erosion, degraded aesthetics, recreation value loss, water pollution, and unnecessary costs.

Prudent vegetation management provides for functional rights-of-way including visual quality, wildlife habitat, biological conditions, physical changes, and recreational potential. Accomplishing acceptable changes includes selecting target vegetation carefully; changing vegetation to conform to acceptable heights and widths; and locating corridors to minimize vegetation treatments. Placing compatible facilities within one corridor minimizes acres required.

Effects on rights-of-way are be identical to those identified in other sections of this chapter. The effects described in this section occur repeatedly and may differ only in timing, intensity, and frequency. Treatments are allowed on rights-of-way to meet legal and safety requirements specified in special-use permits or laws and regulations.

Prescribed fire is not often used, unless included within adjacent prescribed burns. Burns are limited because of the

narrow width of rights-of-way, potential hazard to power poles or from gas leaks along pipelines, and potential increase in erosion.

Corridor maintenance decreases woody vegetation and increases shrubs, herbs, wildflowers, and grasses. Vegetation discoloration and browning occurs on treated areas. Over time, the effects of multiple treatments give the corridor an appearance of permanence, rather than just a temporary disruption. This is primarily a visual effect.

Improved visibility along roads and trails and adequate access to utility lines are created by managing vegetation on rights-of-way. Maintaining vegetation below powerline conductor contact zones allows for uninterrupted electricity flows. Additionally, maintaining grasses and low shrubs on pipelines allows for efficient checking for leaks. Furthermore, investments in facilities are maintained and transportation networks are kept open.

K. VISUAL QUALITY

Introduction

Of all landscape elements, vegetation is the most significant visual feature and is the element most readily manipulated. Manipulation intensity and timing affect the significance of impact on visual quality. A favorable climate and vegetation variety allow vegetation to recover quickly after most treatments. In assessing effects of treatments in each alternative, it is assumed that management requirements and mitigation measures (chapter II) are employed. Also assumed is that visual quality objectives (VQO) for treatment areas may be met, except for alternatives A and H. Variables that affect scenic quality are treatment type, number of acres treated, slope, and duration of effect.

1. Effects of Prescribed Fire

Prescribed fire temporarily reduces understory vegetation and can maintain open forested conditions with more opportunity for views and vistas. Reduction of underbrush creates better pedestrian access. Periodic fire also promotes numerous flowering plants.

Light burns create a charred appearance on tree trunks and lower limbs that lasts 3 to 4 months. With more intense burns and in hot spots, more of the tree is charred and the effect can last 3-5 years or more. Smoke accumulations on relatively calm days reduces visibility in downwind areas. Windier days disperse smoke faster and keep visibility higher, but may affect larger areas.

Repeated treatments of fire in the same area can reduce understory species and maintain side spacing between trees. On rights-of-way variety changes from tall trees to shrubs, herbs, and grasses; however, the number of plants increases

considerably. The vegetation mix remains dynamic and fluctuates with treatments. These changes create a variety of wildflowers, flowering shrubs, grasses, and other plants (Bramble and Byrnes 1982).

2. Effects of Mechanical

Mechanical methods can expose soils and generally reduce vegetation to ground level or less than 3 feet high. Considerable seasonal browning occurs and broken stems create an unsightly landscape. Raking and piling leave debris that may be visible 3 to 4 years before being obscured by new growth, unless the windrows or piles are burned. Mechanical treatments also reduce shading vegetation and allow more wildflowers and other sun-tolerant plants to come into the area until trees and shrubs shade or crowd them out.

3. Effects of Manual

Manual treatments leave browned slash and a graying appearance for a season to a year. Regrowth and residual vegetation obscure the effect within a few months. Canopy heights are reduced, but species variety is generally maintained.

4. Effects of Herbicides

Herbicide treatments reduce variety by eliminating target species, but the space is usually filled quickly by lower-growing shrubs or herbs. Herbicide treatments also create a browning and then a graying that can last from a season to several years depending on the treated vegetation's height and the herbicide's persistence. Frequent treatments such as those on rights-of-way have less lasting visual effects. Broadcast applications create a stronger visual effect than more selective ones. Hand applications generally create irregular or spot patterns of brown and gray. Less total area receives treatment due to the selective application.

5. Effects of Biological

Biological treatment has a negligible effect on visual quality.

L. CULTURAL RESOURCES

Effects on cultural resources are associated with activities that cause soil disturbance, particularly mechanical treatments. There are also limited potentials for effects from fire.

Effects of mechanical treatments increase as depth of penetration into soil or movement of soil from one place to another increases. Effects from fire are generally limited to those resources on or above ground such as buildings.

Vegetation management should not be viewed as a single, isolated activity, but rather as one element of a broader resource management program. Thus, roads, trails, powerlines and pipelines may already have been built and timber may have been harvested. These activities can cause substantial soil disturbance without vegetation management.

Each cultural resource is a piece of a puzzle that tells us about earlier societies. Loss or damage of a single artifact may limit our knowledge and understanding of earlier societies, but this loss may not always be critical. As more artifacts are lost, however, interpretation becomes increasingly difficult. Related to this cumulative loss is the fact that cultural resources are afforded greater protection on Federal lands than on others. Loss or damage of cultural resources on other lands could increase the significance of such resources on Federal lands.

M. SOCIOECONOMIC CONDITIONS

All user groups including workers, neighbors, and visitors identified in chapter III are affected by vegetation management. These effects, however, are dwarfed by the magnitude of other national or even global trends. Effects are related to treatment location, size, method, and tool.

1. Effects on User Expectations

User expectations cover the range from primitive to rural (chapter III). Vegetation management enhances the ability of the forest to meet some expectations and detracts from ability to meet others. Effects on user expectations range from no treatments to low disturbance treatments for a primitive setting of solitude and challenge, to high disturbance treatments for a rural setting of social contact and comfort.

Treatments may change the nature and degree of social conflict related to attitudes, beliefs, and values about the vegetation management program, or even general management of forest resources. Treatments used over long periods or large areas may alter expectations. Expectations are related to the kind and degree of social conflict and acceptance level of the program.

2. Effects on Employment

Despite more substantial influences from regional or national trends, rural communities depend heavily on agriculture/forestry and related services. Employment relates to labor intensity of the practices used (Watson and others 1987). Approximating labor data for the Coastal Plain/Piedmont, the total labor component, including supervision and overhead, for each method is:

*Method	Percent Labor
Mechanical	39
Prescribed Fire (Ground)	67
Prescribed Fire (Aerial)	49
Herbicide (Ground)	26
Herbicide (Aerial)	17
Manual	92

*Biological data are not included in this study, but herd management (labor) represents a small component.

3. Effects on Civil Rights

In every alternative, effects on civil rights, including those of minorities and women, will be statistically insignificant and unplanned. Analysis of possible effects occurs in the site-specific environmental analysis or during project design. The following topics are of concern:

- Risks to worker health and safety because racial and cultural minority groups may represent a large fraction of this work force;

- Employment opportunities and representation in the work force for minorities.

4. Effects on Outputs and Costs

Some outputs are generated at the expense of others, or output levels may change with intensity of treatment. Additionally, costs for conducting vegetation management vary. Some treatments are long-lasting while others must be repeated. Some require little labor or equipment and others require much.

Production of outputs in many cases requires vegetation management. Each multiple use including forage, recreation, water, wildlife, and wood is affected. Conversely, lack of treatment is sometimes essential for these outputs. For example, vegetation management is done to retain or improve vistas for road tours, but little is done in a primitive setting where a closeness to nature is desired. Each is a recreation output and each requires different treatment.

Information on activity cost, acres, method of treatment, and purpose was collected from all Coastal Plain/Piedmont forests and from Watson and others (1987) for work done during fiscal years 1986 and 1987. One ranger district in Florida provided 1985 and 1986 data. These figures represent an expenditure of $11.9 million (labor, materials, handling, equipment, supervision) on 802,138 acres. Average costs by method and tool are shown in table IV-18.

Average costs by activity are:

Pine Management

Activity	Average Cost/Acre
Site Preparation	$61.71
Timber Stand Improvement	21.75
Wildlife Habitat Improvement	5.56
Wildlife Openings Maintenance	65.23
Corridor Maintenance	40.80
Range Forage Maintenance	3.79
Fuels Treatment	3.90

Table IV-18.--Vegetation management costs per acre by method, Coastal Plain/Piedmont

Vegetation Management Method	Per Acre Cost: Coastal Plain	Per Acre Cost: Piedmont	Average Cost/Acre
Herbicide			68.95
Aerial tools			
Helicopter	77.29*		
Mechanical ground tools			
Boom sprayers	71.88	95.30	
Granular spreader	71.76	95.00	
Hand tools			
Backpack sprayers	70.87	84.20	
Spotgun	78.58	87.65	
Hypo-hatchet	41.59	60.01	
Injectors	54.45	58.91	
Hack & Squirt	88.00	101.43	
Backpack sprayers/injectors	61.50*	70.64	
Injectors/hypo-hatchets	50.00	57.50	
Manual			69.95
Power tools	73.64	88.03	
Chainsaws	59.51	66.83	
Brushcutters	89.86	103.34	
Brushcutters/chainsaws	73.64	88.03	
Hand tools			
Axe	74.60	62.50	
Brushhook	77.57	89.20	
Brushcutters/handtools	90.52	104.10	
Brushcutters/brushhook	72.10	82.92	
Brushhook/chainsaw	71.21	81.89	
Mechanical			75.49
Chopping tools	53.62	75.40	
Crushing tools	94.00	108.00	
Scarifying tools	75.49	86.81	
Shearing tools	57.57	66.00	
Piling, raking tools	87.09	100.00	
Disking tools	54.34	62.49	
Bedding tools	42.12	48.50	
Mowing tools	43.70	50.00	
Chopping/shearing/piling/raking	158.60	182.39	
Chopping/shearing/bedding	122.60	140.99	
Chopping/piling, raking/disking	156.04	179.45	
Chopping/disking	85.43	98.24	
Chopping/disking/bedding	113.51	130.54	
Chopping/bedding	76.60	88.09	
Shearing/crushing	121.30	139.50	
Shearing/piling, raking	129.87	149.35	
Shearing/piling, raking/chopping	158.60	182.39	
Shearing/piling, raking/disking	159.20	183.08	
Shearing/piling, raking/bedding	149.40	171.81	
Shearing/piling, raking/mowing	150.70	173.30	
Shearing/disking/bedding	124.88	143.61	
Shearing/bedding	79.80	91.77	
Piling, raking/disking	113.10	130.06	
Prescribed Fire			4.69
Aerial ignition devices	3.58	11.87	
Helitorch	5.66		
Drip, drag torches	4.64	10.29	
Biological - No data			

*Watson, Straka, and Bullard (1987)

Hardwood Management

Activity**	Average Cost/Acre*
Site Preparation	$76.33
Timber Stand Improvement	77.76

*Represents less than 1 percent of sample
**Data not available on other purposes, assumed to be somewhat higher than in pine management.

Vegetation management may change the amount of money passing through the economy, particularly in the form of wages and 25-percent returns to county governments. It may also change indirect costs and opportunity costs. For instance, action or lack of action at the right time and place results in later costs or loss of subsequent benefits. Local or area economics and social structures adjust over the long term to reflect labor force needs, services, and money flowing through the community. Both supply and demand tend to adjust toward equilibrium.

N. SUMMARY OF IMPACTS BY ALTERNATIVES

This section displays overall environmental effects of each alternative. A capsule of the alternative's program is followed by an element-by-element discussion of environmental effects. This section forms the basis for the comparison of alternatives in table II-8.

Alternative A

This is the "no action" alternative. Vegetation management is not done. Existing vegetation is allowed to grow without manipulation.

Human Health and Safety

Neither workers nor the public are exposed to vegetation management tools. Indirect health and safety risks increase over time as vegetation growth encroaches on corridors and builds up fuel loads.

Failure to maintain roadways creates high risks for human health and safety. Roadside vegetation grows uncontrolled and obstructs vision, making roads hazardous within 3-5 years. Road surfaces are also damaged. Risk of power outage results when vegetation grows in rights-of-way and contacts transmission wires.

Exclusion of prescribed fire permits hazardous fuels to accumulate. Wildfire hazard with associated risk to human health and safety is high. Risks of wildfire-related injury increase over time at different rates based on fuel type, age, and other ecological factors.

Vegetation

Succession following timber harvest proceeds uninterrupted except for natural occurrences such as wildfires, tornadoes,

and hurricanes. Complete regeneration failures, as well as marginal survival and loss of growth and form, occur for both natural and planted pine and hardwood species on harvested areas with vigorous competing vegetation. Herbaceous species gradually decline. Shade-tolerant woody species gradually replace shade-intolerant species in the midstory and overstory.

Wildfires occurring during dry weather in accumulations of hazardous fuels are of high intensity, causing significant injury and mortality to vegetation. Greater mortality of woody vegetation occurs during the growing season.

Noxious weeds grow unchecked. Forest visitors are exposed to more weeds resulting in a higher proportion of visitors suffering minor health problems than in alternatives where noxious weeds are controlled.

Wildlife and Aquatic Animals

Prescribed fire and other treatments are unavailable for improving habitat for any species. Fire-dependent species such as quail decline. Because intermediate treatments are not done, regeneration areas rapidly lose their value for species like deer as forage and browse production declines.

Increased wildfires create habitat for early successional species but destroy habitat for mid to late successional species such as brown-headed nuthatch (Sitta pusilla) and pileated woodpecker (Hylatomus pileatus). Species such as grey squirrel benefit from hardmast production, but many species are affected adversely by low soft mast and forage production.

Wildlife openings and rights-of-way lose their value as feeding and nesting areas for species like turkey and rabbits as woody vegetation encroaches. Since no management is done, few downed logs are created for sunning sites for reptiles or cover for amphibians, and few snags are created for raptors or cavity-nesting birds.

Threatened, Endangered, Proposed, and Sensitive Species

Lack of vegetation management, particularly prescribed fire, prevents management of habitat for any species. Habitat is improved for some species but destroyed for others by high intensity wildfires. Many species, especially fire-dependent species like the gopher tortoise and large-flowered bonamia, decline. Although extinction is improbable as long as populations exist on state or private lands, recovery becomes unlikely as habitat suitability declines.

Soil

Lack of underburns allows soil productivity in pine forests to deteriorate naturally through leaching and weathering. Because this process is so slow, effects are insignificant.

Lack of underburns is all fuel types allows wildfire hazard to increase through progressive fuels buildup. Wildfires are estimated to burn about 10 times the present number of acres. Some of these acres are severely burned, resulting in impaired soil productivity.

Water	No treatment effects on water quantity or quality occur. The increase in severe wildfires mentioned above, however, increases stormflows and sediment yields.
Wildfire and Air Quality	Because prescribed fire is not used, wildfires are estimated to increase to at least 120,000 acres per year and are more intense. Annual smoke emissions from national forest lands are estimated to average 73,900 tons per year, all from wildfires.
ROW Corridors	Natural conditions prevail with climax species becoming dominant. Utility lines become non-functional with power outages, roads and railroads interrupted, and trails closed. Unplanned fires are expected along railroads, and facility investments are lost.
Visual Quality	Lack of treatment allows vegetation to encroach on views and vistas. Open, parklike areas eventually disappear with encroachment of midstory and understory vegetation. Wildfires are more intense, often crowning, which increases mortality and creates a negative visual effect.
Cultural Resources	Risk of damage to cultural resources is low because no treatments are allowed. There is an increased risk of damage from wildfires.
Socioeconomic Conditions	Alternative A directly benefits those who enjoy a primitive forest setting, and negatively affects those who enjoy more rural settings. Employment opportunities and direct costs are lowest. Indirect and opportunity costs are highest. Effects on outputs vary extensively, but managed outputs generally decline significantly while unmanaged outputs increase over current levels.
Alternative B	**Vegetation management is done only to protect forest and grassland resources and public health and safety. Minimum risk herbicides are applied by hand. Low disturbance mechanical tools and low intensity prescribed fire are used. Acres treated per year total 130,500.**
Human Health and Safety	Risk to workers is minimal, and exposure is limited by the number of acres treated. Individual workers may be at slight risk because backpack sprayers (the method with the lowest margin of safety for workers) are used.

Slight risk to workers and visitors results from uncontrolled growth of noxious weeds. Resulting injuries are expected to be minor.

Reduced worker exposure to vegetation management tools means that human health dangers are minimized over a person's career. Small number of acres treated reduces risk to individual workers. Wildfire related injuries are less than alternative A but greater than other alternatives. Minimal use of herbicides ensures that all of the chemical is eliminated from the worker's body between exposures. Public exposure is low, and negative effects are insignificant.

Vegetation

Herbicide effects are limited. Selective application methods and herbicides are used on 3,500 acres, resulting in minimal loss of non-target plants. Treatment is primarily to control woody overstory species and favor low woody and herbaceous species.

Prescribed burning at a 5-year cycle in the Coastal Plain marginally controls hazardous fuels buildup. Prescribed burning outside of hazardous areas does not occur. Fuels buildup in those areas continues unchecked but reaches equilibrium in 10 to 20 years. During dry weather, some vegetation injury and mortality occur in areas not normally considered as having hazardous fuels.

Succession following timber harvest proceeds uninterrupted except for natural occurrences such as wildfires, tornadoes, and hurricanes. Complete regeneration failures, as well as marginal survival and loss of growth and form, occur for both natural and planted pine and hardwood species on harvested areas with vigorous competing vegetation. Herbaceous species gradually decline. Shade-tolerant woody species gradually replace shade-intolerant species in the midstory and overstory.

Wildlife and Aquatic Animals

Effects are similar to alternative A, but fire-dependent species benefit slightly more since some prescribed burning occurs. Maintained rights-of-way produce habitat and some "edge" for species like rabbits.

Threatened, Engangered, Proposed, and Sensitive Species

Because of limited management, known populations are maintained but recovery is not likely.

Soil

Underburns occur only in pine-heavy brush fuel types. Soil productivity in other pine fuel types deteriorates naturally through leaching and weathering. Because this process is so slow, effects are insignificant.

Lack of underburns in all but pine-heavy brush types allows wildfire hazard to increase through progressive fuels buildup. Wildfires are estimated to burn about 6.8 times the present number of acres. Some acres are severely burned, resulting in impaired soil productivity.

Underburns occur every 5 years generally and 3 years in habitat for sensitive, threatened, and endangered species, only in the dormant season. Slash burns, piling, and raking are not used. Effects on soil productivity from all tools are minimal.

Water

Site preparation is not done and corridor maintenance occurs on only 17,000 acres. Treatments produce about 100 tons of sediment per year. Treatment effects on stormflows and herbicide concentrations are minimal. The increase in severe wildfires mentioned above, however, produces increases in stormflows and sediment yields.

Wildfire and Air Quality

Underburns occur on 113,500 acres per year in pine-heavy brush fuels. Wildfires are estimated to increase to at least 81,000 acres per year and are more intense. Annual smoke emissions from national forest lands are estimated to average 11,900 tons from prescribed fire and 36,300 tons from wildfire, for a total of 48,200 tons.

ROW Corridors

Maintenance is performed to protect investments and prevent safety hazards. Understory vegetation is normally unmanaged with an uneven overstory having taller woody plants that reach maximum height under powerlines and maximum widths along road rights-of-way. Additional manpower is needed to accomplish these treatments. The small acreages assigned to mechanical and manual treatments may be insufficient to meet safety and investment protection levels.

Visual Quality

Visual impacts are minimal and activities are performed to meet established visual-quality objectives.

Cultural Resources

Alternative B has the lowest risk because fire protection is allowed and mechanical treatments do not disturb soils.

Socioeconomic Conditions

Alternative B favors primitive expectations and outputs which require little management similar to alternative A while opportunity and indirect costs are diminished and employment opportunities increase slightly (far below current). Total cost of the program is $2.03 million and per acre treatment cost is $15.54.

Alternative C

Vegetation management is restricted to methods that achieve selective (target-specific) control or cause limited site disturbance. Minimum risk herbicides are applied by hand. Low disturbance mechanical tools and low intensity prescribed fire are used. Acres treated per year total 414,500.

Human Health and Safety

Herbicides applied exclusively by manual methods cause a somewhat greater health risk to individual workers than at present. Margins of safety for all chemicals are lowest for this type of application. Low level of herbicide usage, however, should cause low total worker and public exposure to herbicide.

Low level of herbicide use in this alternative means that other methods are used to accomplish vegetation management goals. Other methods have a higher rate of accident occurrence than herbicides, so a relatively high rate of injury is expected. No risk from other methods is expected for the public.

Distributions of accidents by cause and frequency are not expected to change from present. About 20 percent less acreage is treated than at present, which results in fewer total accidents.

Vegetation

The effects of herbicides on vegetation are similar to "B" but occur on 17,000 acres. Effect on non-target vegetation continues to be lower than at present due to the selectivity of the tools and the number of acres treated.

Prescribed burning at a 5-year cycle (Coastal Plain) and a 7-year cycle (Piedmont) marginally controls the buildup of hazardous fuels. Low intensity growing and dormant season burns at these cycles produce a mix of woody and herbaceous species. Dormant season burns predominate producing a greater number of woody species in the understory and midstory. Herbaceous species decrease in number.
Range burns on a 5-year cycle marginally maintain range forage species. Some preferred forage plants decline.

Mechanical tools causing only low soil disturbance are used. Herbaceous species initially increase, then after 3 years begin to decline. Woody species initially decline, but most recover within 5 years. Mortality of woody species due to uprooting is very low.

Moderate amounts of manual methods are used. Repeated treatments must occur on sites with high numbers of competing stems in order to successfully release or precommercially thin pine and hardwood seedlings or saplings.

Areas where grazing is used as a biological method have some pine and hardwood seedling losses from plant injury or mortality. Heavy grazing intensities cause shifts in herbaceous species composition.

Wildlife and Aquatic Animals

The 5-7 year prescribed burning cycle is more beneficial for deer and turkey than limited or no burning, but allows browse, forage, and soft mast to decline. Species like meadowlarks, which use very early successional stage habitat, have less habitat than when more intensive site preparation methods are used. Species such as grey squirrel benefit from selective herbicide treatments which are less detrimental to hard and soft mast producers than broadcast treatments. Snags are created for raptors and cavity nesters. Downed logs are provided for reptiles and amphibians.

Threatened, Endangered, Proposed, and Sensitive Species	All vegetation management methods are available for habitat management. Mitigation measures assure adequate inventory of proposed, sensitive, threatened, and endangered species and protect populations from adverse effects of vegetation management. Recovery is likely if impacts from external factors are controlled.
Soil	Underburns occur every 5 years in the Coastal Plain, 7 years in the Piedmont, and 2 years in habitat for sensitive, threatened, and endangered species. Use of growing season burns is minor. Slash burns compose 25 percent of site preparation acres and are estimated to be 70 percent light and 30 percent moderate. Piling and raking are not used. Use of biological methods is minor. In general, 2-year underburns pose medium risks to soil productivity. Other underburns and moderate slash burns pose low risks to productivity of depleted soils only. Biological methods pose high risks from heavy grazing. Effects of all other tools are minimal. Over time, risks to soil productivity from vegetation management are estimated to be low on 70,700 acres, medium on 78,800 acres, and high on 15,000 acres.
Water	Annual treatment acres are 35,500 for site preparation and 23,300 for corridor maintenance. Treatment intensity is low, producing about 620 tons of sediment per year. Effects on stormflows and herbicide concentrations are minimal.
Wildfire and Air Quality	Slash burns occur on 8,900 acres per year, underburns on 346,100 acres per year, and wildfires on an estimated 15,000 acres per year. Annual smoke emissions from national forest lands are estimated to average 36,700 tons from prescribed fire and 4,400 tons from wildfire, for a total of 41,100 tons.
ROW Corridors	Maintenance is performed to protect investments and prevent safety hazards. Understory vegetation is normally unmanaged with an uneven overstory having taller woody plants that reach maximum height under powerlines and maximum widths along road rights-of-way. Additional manpower is needed to accomplish these treatments. The small acreages assigned to mechanical and manual treatments may be insufficient to meet safety and investment protection levels.
Visual Quality	Visual impacts are less than at present because fewer acres are treated. Visitors viewing treated areas see evidence of treatments, but degree of change should be visually acceptable when Retention and Partial Retention visual-quality objectives are met.
Cultural Resources	More acres are treated by mechanical methods than in alternative B, but tools that cause low soil disturbance are used. Risks are higher than A or B but still in the low range.

Socioeconomic Conditions

Unmanaged outputs are emphasized, and managed outputs are at levels well below current. Indirect and opportunity costs are high. Employment opportunities are more favorable than alternative B but below current. Treatments result in settings favored by those nearer the primitive end of the expectations scale. Total cost is in the low range at $5.97 million, but about three times that of alternative B. Per acre costs are $14.40, the lowest of any alternative.

Alternative D

Herbicides are not used. Mechanical tools cause low to moderate disturbance. Prescribed fire is of low to moderate intensity. Acres treated per year total 553,500.

Human Health and Safety

No use of herbicides in this alternative means that other methods are used to accomplish vegetation management goals. Other methods, especially manual, have a higher rate of accident occurrence, so a relatively high rate of worker injury is expected. Public perception of safety improves, but, worker safety declines while public safety is not affected.

Vegetation

Prescribed burning at a 4-year cycle (Coastal Plain) and 6-year cycle (Piedmont) adequately controls the buildup of hazardous fuels. Low to moderate intensity, growing and dormant season burns at these cycles produce a mix of woody and herbaceous mid- and understory species. Growing season burns, however, can be expected to produce a greater number and variety of herbaceous species. Range burns on a 3-year cycle sustain a mix of preferred range forage species consisting of native grasses, forbs, and legumes.

Mechanical tools causing low to moderate soil disturbance are used . Herbaceous species initially increase, then decline within 3 to 5 years, depending upon tool intensity. Woody species initially decline. Higher intensity tools or combinations (such as shearing and piling, or disking and bedding) produce a greater decline. Since no raking or heavy disking occurs, mortality of woody species through uprooting is very low. Woody species fully recover within 5 to 10 years following treatment.

Moderate amounts of manual methods are used. Repeated treatments must occur on sites with high numbers of competing stems in order to successfully release or precommercially thin pine and hardwood seedlings or saplings.

Areas using grazing as a biological method have some pine and hardwood seedling losses from plant injury and mortality. Heavy grazing intensities cause shifts in herbaceous species composition.

Wildlife and Aquatic Animals

All methods except herbicides are available to manage for a broad range of wildlife species. High use of mechanical

tools creates habitat for species like doves which use very early successional stage habitat. The 4-6 year prescribed burning cycle improves habitat for fire-dependent species and is generally favorable for species needing soft mast, such as deer and turkey. Absence of broadcast herbicide treatments favors hard and soft mast producers used by many species. Mechanical site preparation leaves fewer snags than alternative C but creates more downed logs used by reptiles and amphibians, unless combined with slash burning.

Threatened, Endangered, Proposed, and Sensitive Species	All methods but herbicides are available for habitat management. Mitigation measures assure adequate inventory of proposed, sensitive, threatened, and endangered species and protect populations from adverse effects of vegetation management. Recovery is likely if impacts from external factors are controlled.
Soil	Underburns occur every 4 years in the Coastal Plain, 6 years in the Piedmont, and 2 years in habitat for sensitive, threatened, and endangered species. Use of growing season burns is significant. Slash burns compose 35 percent of site preparation acres and are estimated to be 50 percent light and 50 percent moderate. Piling composes 30 percent of site preparation acres, but raking is not used. Use of biological methods is low.

In general, 2-year underburns pose medium risks to soil productivity. Other underburns, moderate slash burns, and piling pose low risks to productivity of depleted soils only, but growing season underburns increase risks where they are used. Biological methods pose high risks from overgrazing. Effects of all other tools are minimal. Over time, risks to soil productivity from vegetation management are estimated to be low on 119,600 acres, medium on 78,800 acres, and high on 30,000 acres.

Water	Annual treatment acres are 50,000 for site preparation and 40,500 for corridor maintenance. Herbicides are not used, so effects on herbicide concentrations are nil. Treatment intensity is low to moderate, producing about 1,050 tons of sediment per year. Effects on stormflows are minimal.
Wildfire and Air Quality	Slash burns occur on 17,500 acres per year, underburns on 446,500 acres per year, and wildfires on an estimated 12,000 acres per year. Annual smoke emissions from national forest lands are estimated to average 42,100 tons from prescribed fire and 3,100 tons from wildfire, for a total of 45,200 tons.
ROW Corridors	Without herbicide use, mechanical and manual methods increase on rights-of-way to maintain the facilities' structural integrity, meet safety requirements, and protect investments. Mechanical treatments replace herbicide treatments, which causes machinery and labor costs to increase. Because some areas might be inaccessible by mechanical methods, high cost-per-acre treatments or occasional power outages from vegetation reaching powerline conductors result.
Visual Quality	Visual impacts result mainly from prescribed fire and mechanical treatments. Visitors viewing the treated areas see significant vegetation disruption for 3 to 4 months after treatments. Treatments normally meet retention to modification visual-quality standards.
Cultural Resources	The high number of acres treated by mechanical methods increases risk of damage to cultural resources, but low to moderate disturbance tools mitigate some of this risk.
Socioeconomic Conditions	Elimination of herbicides affects the level of social conflict. Those who favor primitive settings are adversely affected by an increased use of mechanical but aided by an increased use of hand methods over the current program. Total costs are $8.76 million and per acre costs are comparable to current costs at $15.82.
Alternative E	**Manual methods and prescribed fire are the major means of vegetation control. Minimum risk herbicides are applied by hand and machine. Mechanical tools cause low to moderate disturbance. Prescribed fire is of low to moderate intensity. Acres treated per year total 553,500.**
Human Health and Safety	Mix of herbicide application tools and restricted amount of herbicide treatment keeps herbicide-related health risks low. Increased hand-tool work results in a high rate of accidental lacerations from chain saws and cutting tools.
Vegetation	Choice of herbicide and application method allows either selective or broadcast treatments of granular and liquid

herbicides. The overall effect on vegetation is less than for either "C" or "F" primarily due to the reduced number of acres (11,500) treated. While risk to non-target vegetation is greater for broadcast treatments, low acreage of treatment keeps overall risk to non-target vegetation low.

Prescribed burning at a 4-year cycle (Coastal Plain) and 6-year cycle (Piedmont) adequately controls the buildup of hazardous fuels. Low to moderate intensity, growing and dormant season burns at these cycles produce a mix of woody and herbaceous mid- and understory species. Growing season burns, however, can be expected to produce a greater number and variety of herbaceous species. Range burns on a 3-year cycle sustain a mix of preferred range forage species consisting of native grasses, forbs, and legumes.

Mechanical tools causing low to moderate soil disturbance are used . Herbaceous species initially increase, then decline within 3 to 5 years, depending upon tool intensity. Woody species initially decline. Higher intensity tools or combinations (such as shearing and piling, or disking and bedding) produce a greater decline. Since no raking or heavy disking occurs, mortality of woody species through uprooting is very low. Woody species fully recover within 5 to 10 years following treatment.

High use of manual methods in more areas causes a substantial increase in the amount of repeated treatments on sites with high numbers of competing stems in order to successfully release or precommercially thin pine and hardwood seedlings or saplings.

Areas using grazing as a biological method have some pine and hardwood seedling losses from plant injury and mortality. Heavy grazing intensities cause shifts in herbaceous species composition.

Wildlife and Aquatic Animals

High use of manual and low use of mechanical tools should selectively favor hard and soft mast producing woody plants. Adverse effects on mast producers from herbicides are greater than in alternative D but less than in alternative C. Methods used create less habitat for species such as dove, which use very early successional stage habitat, than intensive mechanical tools. Fire-dependent species benefit from an extensive burning program on a 4-6 year cycle, which improves browse, forage, and soft mast production.

Threatened, Endangered, Proposed, and Sensitive Species

All methods are available for habitat management. Mitigation measures assure adequate inventory of proposed, sensitive, threatened, and endangered species and protect populations from adverse effects of vegetation management. Recovery is likely if impacts from external factors are controlled.

Soil	Underburns occur every 4 years in the Coastal Plain, 6 years in the Piedmont, and 2 years in habitat for sensitive, threatened, and endangered species. Use of growing season burns is significant. Slash burns compose 50 percent of site preparation acres and are estimated to be 50 percent light and 50 percent moderate. Piling composes only 5 percent of site preparation acres, and raking is not used. Use of biological methods is moderate. In general, 2-year underburns pose medium risks to soil productivity. Other underburns, moderate slash burns, and piling pose low risks to productivity of depleted soils only, but growing season underburns increase risks where they are used. Biological methods pose high risks from heavy grazing. Effects of all other tools are minimal. Over time, risks to soil productivity from vegetation management are estimated to be low on 103,300 acres, medium on 78,800 acres, and high on 45,000 acres.
Water	Annual treatment acres are 50,000 for site preparation and 40,500 for corridor maintenance. Manual methods and prescribed fire are favored for site preparation, and low to moderate treatment intensity produces about 660 tons of sediment per year. Effects on stormflows and herbicide concentrations are minimal.
Wildfire and Air Quality	Slash burns occur on 25,000 acres per year, underburns on 447,000 acres per year, and wildfires on an estimated 12,000 acres per year. Annual smoke emissions from national forest lands are estimated to average 43,800 tons from prescribed fire and 3,100 tons from wildfire, for a total of 46,900 tons.
ROW Corridors	Treatment methods for effective control are available and target species are controlled. Species having desired height, width, and density are favored. Plant species are promoted to enhance wildlife habitat and food, provide recreation potential and aesthetic value, and reduce overall maintenance costs.
Visual Quality	Visual impacts result mainly from prescribed fire and mechanical treatments. Visitors viewing the treated areas see significant vegetation disruption for 3 to 4 months after treatments. Treatments normally meet retention to modification visual-quality standards.
Cultural Resources	Fewer acres treated mechanically, and use of tools causing low to moderate soil disturbance reduces risks from present.
Socioeconomic Conditions	This alternative has the highest potential for employment and favors primitive experiences somewhat more than present. Opportunity costs and indirect costs compare with alternative C. Total program costs are $7.99 million, lower than current but higher than alternatives B and C. Per acre costs are $14.43, comparable to alternative C.

Alternative F — **This alternative continues present levels of treatment specified in the Forest Land and Resource Management Plans. Herbicides are applied by hand and machine. Mechanical tools cause low to high disturbance. Prescribed fire is of low to high intensity. Acres treated per year total 553,500.**

Human Health and Safety — Typical herbicide use levels pose no health risk to the public. Workers are exposed to risk only when using 2,4-D, 2,4-DP, or tebuthiuron, and then only with certain application methods. At maximum use rates, several of the herbicides pose risks to workers and the public. About 12 vegetation management related injuries occur per year, and about half of them are serious.

Vegetation — The effects of herbicide treatments are similar to "E". Use of less selective broadcast treatments on larger acreage increases potential for damage to non-target vegetation. Herbicides are used on 27,000 acres. Temporary reduction of competing vegetation is achieved. Broadcast treatments increase herbaceous species and reduce woody species.

Prescribed burning at a 4-year cycle (Coastal Plain) and 6-year cycle (Piedmont) adequately controls the buildup of hazardous fuels. Growing and dormant season burns are used to produce a mix of woody and herbaceous mid- and understory species. Where growing season burns are used a greater number and variety of herbaceous species will be produced. Use of higher intensity fire in this alternative further reduces woody species and increases herbaceous species. Range burns on a 3-year cycle sustain a mix of preferred range forage species consisting of native grasses, forbs, and legumes.

Mechanical tools causing low to high soil disturbance are used . Herbaceous species initially increase, then decline within 3 to 5 years, depending upon tool intensity. Woody species initially decline. Higher intensity tools or combinations produce a greater decline. Some mortality of woody species occurs through uprooting by raking and disking. Most woody species fully recover within 5 to 10 years following treatment.

Low to moderate amounts of manual methods are used, causing repeated treatments on sites with high numbers of competing stems in order to successfully release or precommercially thin pine and hardwood seedlings or saplings. No biological methods are used.

Wildlife and Aquatic Animals — A wide range of vegetation management tools provides a variety of habitats and successional stages for many species. Deer and turkey populations benefit from prescribed burning, opening maintenance, and other habitat improvement treatments. Prescribed burning frequencies are

similar to alternative E, but some intense burns occur, providing very early successional stage habitat. Mast producers are often not favored due to use of non-selective treatments. Fewer snags for cavity nesters and downed logs for reptiles and amphibians are created than in alternative E.

Threatened, Endangered, Proposed, and Sensitive Species	All methods are available for habitat management. Mitigation measures assure adequate inventory of proposed, sensitive, threatened, and endangered species and protect populations from adverse effects of vegetation management. Recovery is likely if impacts from external factors are controlled.
Soil	Underburns occur every 4 years in the Coastal Plain, 6 years in the Piedmont, and 2 years in habitat for sensitive, threatened, and endangered species. Use of growing season burns is significant. Slash burns compose 25 percent of site preparation acres and are estimated to be 30 percent light, 50 percent moderate, and 20 percent severe. Piling and raking compose 21 and 5 percent of site preparation acres, respectively. Biological methods are not used. In general, 2-year underburns pose medium risks to soil productivity. Other underburns, moderate slash burns, and piling pose low risks to productivity of depleted soils only, but growing season underburns increase risks where they are used. Severe slash burns and raking pose high risks on rich soils and extreme risks on poor and depleted soils. Effects of all other tools are minimal. Over time, risks to soil productivity from vegetation management are estimated to be low on 76,900 acres, medium on 78,800 acres, high on 192,800 acres, and extreme on 41,200 acres.
Water	Annual treatment acres are 50,000 for site preparation and 40,500 for corridor maintenance. Treatment intensity is low to high, producing about 1,610 tons of sediment per year. Effects on stormflows and herbicide concentrations are minimal.
Wildfire and Air Quality	Slash burns occur on 12,500 acres per year, underburns on 450,500 acres per year, and wildfires on an estimated 12,000 acres per year. Annual smoke emissions from national forest lands are estimated to average 41,400 tons from prescribed fire and 3,100 tons from wildfire, for a total of 44,500 tons.
ROW Corridors	Treatment methods for effective control are available and target species are controlled. Species having desired height, width, and density are favored. Plant species are promoted to enhance wildlife habitat and food, provide recreation potential and aesthetic value, and reduce overall maintenance costs.

Visual Quality

Visual impacts result from prescribed fire, mechanical, and herbicide treatments. Visitors viewing treated areas see significant vegetation disruption and ground disturbance for 3 to 6 months after treatments. If piled debris isn't burned, this effect stays visible for 2 to 3 years. Treatments may meet visual-quality objectives for retention to maximum modification.

Cultural Resources

Alternative F allows the full range of mechanical treatments, low to high soil disturbance, and the greatest risk of effects, except for alternative H which treats more acres.

Socioeconomic Conditions

Alternative F provides a moderate level of employment opportunity. All expectation levels are managed, with semi-primitive motorized class and roaded-natural class having the most acres. Total program costs are $8.80 million, higher than all other alternatives except H. Per acre costs are highest at $15.90.

Alternative G

Prescribed fire and herbicides are the major means of vegetation control. Minimum risk herbicides are applied by hand, machine, and air. Mechanical tools cause low to moderate disturbance. Prescribed fire is of low to moderate intensity. Acres treated per year total 553,500.

Human Health and Safety

About 1.8 times as many acres are treated with herbicides than currently. Increase in acreage treated with herbicides exposes more individuals and increases potential for accidental spill. However, additional mitigation, including use of minimum-risk herbicides and application methods, increases individual safety.

Increased treated acreage could increase visitor exposure. If posted warning signs are observed, however, no exposure should occur. Drift from aerial operations is not a problem if management requirements and mitigation measures in chapter II are followed. No negative public health effects are projected at typical application rates.

Vegetation

Increased use of herbicide treatments, plus introduction of aerial application by helicopter, puts non-target vegetation at a higher risk.

Prescribed burning at a 4-year cycle (Coastal Plain) and 6-year cycle (Piedmont) adequately controls the buildup of hazardous fuels. Low to moderate intensity, growing and dormant season burns at these cycles produce a mix of woody and herbaceous mid- and understory species. Growing season burns, however, can be expected to produce a greater number and variety of herbaceous species. Range burns on a 3-year

cycle sustain a mix of preferred range forage species consisting of native grasses, forbs, and legumes.

Mechanical tools causing low to moderate soil disturbance are used. Herbaceous species initially increase, then decline within 3 to 5 years, depending upon tool intensity. Woody species initially decline. Higher intensity tools or combinations (such as shearing and piling, or disking and bedding) produce a greater decline. Since no raking or heavy disking occurs, mortality of woody species through uprooting is very low. Woody species fully recover within 5 to 10 years following treatment.

Low amounts of manual methods are used. Some repeated treatments occur on sites with high numbers of competing stems in order to successfully release or precommercially thin pine and hardwood seedlings or saplings.

Areas using grazing as a biological control method have some pine and hardwood seedling losses from plant injury and mortality. Heavy grazing intensities cause shifts in herbaceous species composition.

Wildlife and Aquatic Animals

Management is similar to alternative F. An increase in broadcast herbicide application reduces hard and soft mast producers used by many animals including deer, turkey, and squirrel on some sites, but increased use of selective methods favors mast producers on others. Prescribed burning frequencies and intensities produce effects similar to alternative E. Low use of mechanical tools leaves snags for raptors but fewer downed logs for reptiles and amphibians.

Threatened, Endangered Proposed, and Sensitive Species

All methods are available for habitat management. Mitigation measures assure adequate inventory of proposed, sensitive, threatened, and endangered species and protect populations from adverse effects of vegetation management. Recovery is likely if impacts from external factors are controlled.

Soil

Underburns occur every 4 years in the Coastal Plain, 6 years in the Piedmont, and 2 years in habitat for sensitive, threatened, and endangered species. Use of growing season burns is significant. Slash burns compose 30 percent of site preparation acres and are estimated to be 50 percent light and 50 percent moderate. Piling composes 21 percent of site preparation acres, but raking is not used. Use of biological methods is minor.

In general, 2-year underburns pose medium risks to soil productivity. Other underburns, moderate slash burns, and piling pose low risks to productivity of depleted soils only, but growing season underburns increase risks where they are used. Biological methods pose high risks from heavy grazing. Effects of all other tools are minimal.

	Over time, risks to soil productivity from vegetation management are estimated to be low on 80,000 acres, medium on 78,800 acres, and high on 15,000 acres.
Water	Annual treatment acres are 50,000 for site preparation and 40,500 for corridor maintenance. Herbicides and prescribed fire are favored for site preparation, and low to moderate treatment intensity produces about 1,030 tons of sediment per year. Effects on stormflows and herbicide concentrations are generally minimal. Aerial treatments, however, pose risks of accidental direct application of herbicides to streams.
Wildfire and Air Quality	Slash burns occur on 19,500 acres per year, underburns on 447,000 acres per year, and wildfires on an estimated 12,000 acres per year. Annual smoke emissions from national forest lands are estimated to average 42,000 tons from prescribed fire and 3,100 acres from wildfire, for a total of 45,100 tons.
ROW Corridors	Treatment methods for effective control are available and target species are controlled. Species having desired height, width, and density are favored. Plant species are promoted to enhance wildlife habitat and food, provide recreation potential and aesthetic value, and reduce overall maintenance costs.
Visual Quality	Visual impacts result mostly from prescribed fire and herbicide treatments. Effects from most prescribed fire should be insignificant after 3 to 4 months. Broadcast herbicide applications create seasonal browning that attracts viewer attention. Treatments meet visual quality objectives from retention to maximum modification.
Cultural Resources	Fewer acres treated mechanically, and use of tools causing low to moderate soil disturbance reduces risks from present.
Socioeconomic Conditions	Alternative G favors experiences nearer the primitive end of the scale. Social conflict is affected by this attention to primitive expectations and the addition of aerial herbicide application. Total costs are about $8.37 million and per acre costs are $15.11, about 5 percent less than present.
Alternative H	**Vegetation management is done to achieve maximum vegetation control. Herbicides are broadcast at maximum effective rates by hand, machine, and air. High disturbance mechanical tools and intense prescribed fires are used more frequently than at present. Repeat entries occur on highly productive lands. Acres treated per year total 801,000.**
Human Health and Safety	Aerial application of herbicides reduces average risk to herbicide applicators. About twice as many acres, however,

are treated than currently, so more workers are exposed and the probability of an accidental spill increases. Because effectiveness of control is the major concern, human health and safety are important but less emphasized.

Despite increased acres treated, risks to public health are not projected to increase at typical application rates. Visitors obeying posted warnings should not be exposed to herbicides in treated areas and so are not at risk.

Increased use of fire to control unwanted vegetation is expected to lead to an increase in the number of tripping, falling, and slipping injuries. Smoke inhalation and relatively minor injuries will increase, but no significant increase in disabling injuries occurs from present.

Vegetation

Increased acreage treated using herbicides, and increased frequency and intensity of treatments, permit almost complete control of competing woody or herbaceous vegetation and puts non-target vegetation at highest risk. Broadcast herbicide application by helicopter, mechanical sprayers, or hand ground tools occurs on 65,500 acres.

Prescribed burning at a 3-year cycle (Coastal Plain) and a 5-year cycle (Piedmont) more than adequately controls the buildup of hazardous fuels. Growing and dormant season burns at these cycles produce a mix of woody and herbaceous mid- and understory species. Reductions in some woody species reproduction and development occurs, and greater numbers of herbaceous species predominate. Use of higher intensity fire also reduces woody species and increases herbaceous species. Range burns on a 2-year cycle maintain high amounts of primarily grass species, as well as some forbs and legumes.

Mechanical tools causing low to high soil disturbance are used. Herbaceous species initially increase, then decline within 3 to 5 years, depending upon tool intensity. Woody species initially decline. Higher intensity tools or combinations produce a greater decline. Some mortality of woody species occurs through uprooting by raking and disking. Most woody species fully recover within 5 to 10 years following treatment.

Areas using grazing as a biological control method have some pine and hardwood seedling losses from plant injury or mortality. Heavy grazing intensities cause shifts in herbaceous species composition.

Wildlife and Aquatic Animals

Maximum vegetation control limits production of hard and soft mast and browse used by deer, turkey and other species. Higher burning intensity and frequency combined with herbicide treatments severely reduce hardwood midstories

	used by songbirds like tufted titmouse (*Parus bicolor*), but may increase soft mast production. Increased siltation from intense mechanical treatments impairs quality of aquatic habitats. Snags for raptors and downed logs for reptiles and amphibians are less available than in other alternatives.
Threatened Endangered, Proposed, and Sensitive Species	All methods are available for habitat management. Mitigation measures assure adequate inventory of proposed, sensitive, threatened, and endangered species and protect populations from adverse effects of vegetation management. Recovery is likely if impacts from external factors are controlled.
Soil	Underburns occur every 3 years in the Coastal Plain, 5 years in the Piedmont, and 2 years in habitat for sensitive, threatened, and endangered species. Use of growing season burns is significant. Slash burns compose 15 percent of site preparation acres and are estimated to be 20 percent light, 50 percent moderate, and 30 percent severe. Piling and raking each compose 18 percent of site preparation acres. Biological methods are used aggressively. In general, 2-year underburns pose medium risks to soil productivity. Other underburns, moderate slash burns, and piling pose low risks to productivity of depleted soils only, but growing season underburns increase risks where they are used. Severe slash burns and raking pose high risks on rich soils and extreme risks on poor and depleted soils. Biological methods pose high risks from heavy grazing. Effects of all other tools are minimal. Over time, risks to soil productivity from vegetation management are estimated to be low on 77,700 acres, medium on 192,800 acres, high on 625,400 acres, and extreme on 136,400 acres.
Water	Annual treatment acres are 50,000 for site preparation and 57,000 for corridor maintenance. Broadcast herbicides, intensive mechanical techniques, and intense prescribed fire are favored in site preparation. Treatments produce about 3,200 tons of sediment per year. Effects on stormflows and herbicide concentrations are generally minimal. Aerial treatments, however, pose the greatest risks of accidental direct application of herbicides to streams.
Wildfire and Air Quality	Slash burns occur on 7,500 acres per year, underburns on 659,500 acres per year, and wildfires on an estimated 9,000 acres per year. Annual smoke emissions from national forest lands are estimated to average 48,900 tons from prescribed fire and 2,300 tons from wildfire, for a total of 51,200 tons.
ROW Corridors	Treatment methods for effective control are available and target species are controlled. Species having desired height, width, and density are favored. Plant species are promoted to enhance wildlife habitat and food, provide recreation potential and aesthetic value, and reduce overall maintenance costs.

Visual Quality

This alternative creates significant visual impacts with more treatment acres meeting the maximum modification visual quality objective. Prescribed fire, mechanical, and herbicide treatments are used more and at higher intensity. These increases result in significant visual color and textural changes readily noticed by visitors. Individual treatment effects may not meet the assigned visual quality objective to achieve other resource objectives.

Cultural Resources

The full range of mechanical treatments, causing low to high soil disturbance, pose the greatest risk of negative effects. More acres are treated than in other alternatives which also increases risk.

Socioeconomic

Intense practices strongly favor the rural experience. Those who favor primitive experiences are most negatively affected. Social conflict is similar to alternative G because aerial application of herbicides is available. Total costs are highest at $12.62 million, and per-acre costs are $15.75.

O. RESEARCH NEEDS

As this analysis was conducted, the need for additional research was identified in several areas. Research is an integral part of work done on national forests and is used to acquire knowledge of environmental processes and relationships on forests and rangelands. Information concerning effects of vegetation management, derived from existing research studies, form the basis for most of the conclusions of this document. Here are the major research needs identified:

1. Public, worker, and wildlife exposure from use of different herbicides and application rates.

2. Long-term effects on soil and water from varying severity of slash burns and from varying frequency and season of underburns.

3. Relationship of prescribed fire effects on wildlife (especially reptiles, amphibians, and songbirds) to fire behavior, including intensity, duration, and season.

4. Effects of prescribed burning on growth of different size classes of yellow pines.

5. Effect of air pollutants on growth and reproduction.

6. Composition, interrelationships, and potential indicator species of understory plant communities.

7. Effectiveness of biological vegetation controls, including light inhibitors, livestock, insects, and allelopathic plants.

8. Long-range (multi-rotational) effects on wildlife and plants from vegetation management, including growing and dormant season burns.

9. Competition between wildlife and domestic animals for available vegetation.

10. Long-term effects of intensive mechanical site preparation treatments on soil, water, reptiles, and amphibians.

11. Effects of bedding on seedling survival and understory plant communities.

12. Effects of vegetation management methods on streamflows and channel erosion, and rates of channel erosion in undisturbed forests.

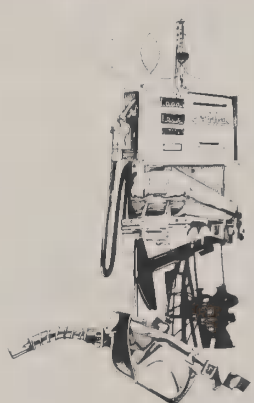
13. Herbicide effects on wildlife, including effects on habitat, chronic toxicity, and oncogenic and mutagenic potential.

14. Synergistic and cumulative effects of herbicides.

15. Effects of alternating dormant and growing season burns on plant communities.

16. Long-term effects on animals, especially threatened, endangered, and sensitive species, associated with plant communities that are treated with specific combinations of herbicides and periodic fire.

P. ENERGY REQUIREMENTS



The principal energy source for vegetation management is fossil fuel. Every alternative except A consumes fuel (usually petroleum) either directly, such as in vehicles, machinery and equipment, or indirectly, such as an ingredient in herbicides or in a manufacturing process. Another energy source which is sometimes consumed is logging debris which has potential household or industrial uses.

Energy requirements for vegetation management are only a small part of the total energy required for all management activities occurring on national forests. While there are variations between alternatives (A uses none, B requires the least, and H requires the most), these variations are not significant.

Q. POSSIBLE CONFLICTS WITH OTHERS

Other local, State and Federal agencies have vegetation management programs of their own and may be affected by this analysis. Some of these agencies have overlapping responsibilities with the Forest Service, and some have administrative authorities to prescribe limits on certain types of adverse effects.

None of these agencies asked to be a formal cooperator under the provisions of the National Environmental Policy Act. However, many have participated in the preparation of this environmental impact statement:

- The Environmental Protection Agency has provided information on environmental standards and testing procedures.
- The Fish and Wildlife Service has assisted with data and requirements for compliance with the Endangered Species Act.
- The Tennessee Valley Authority (a quasi-governmental agency) has assisted with rights-of-way analysis and provided cost statistics.
- State Foresters have been represented by two part-time team members and have reviewed some analytical results.
- Finally, chapter VI contains a list of numerous agencies at all levels which will review this document.

Few apparent conflicts with others have been noted. One is that management intensities on national forests can be expected to differ from intensities on other lands. The uninformed visitor could have unrealistic expectations that all lands should have similar management, particularly when they are adjacent. Management intensities will differ depending on the mission and objectives of the responsible agency.

Alternatives A and B reduce payments to local governments. Selection of either of these alternatives requires more intense coordination with these governments because both of these alternatives envision substantial program revisions .

The most significant potential conflict is internal; with Forest Land and Resource Management Plans. Plans assumed that all vegetation management methods are available. The Regional Forester's decision about which mix of methods to use, based on this analysis, could be different from assumptions in Plans. Forest Supervisors will evaluate the Regional Forester's decision and its effect on Plans and make revisions as needed.

R. ADVERSE EFFECTS THAT CANNOT BE AVOIDED

Despite mitigation measures, some significant adverse effects are unavoidable, some in alternative A only, and some in any alternative where vegetation management is done. These effects are:

1. Health and Safety

Worker accidents occur through use of vegetation management methods.

2. Vegetation

Individual non-target plants are injured or killed by vegetation management methods. Some methods and techniques have greater effects than others.

3. Wildlife and Aquatic Animals

Wildlife requiring mature forests is displaced or lost from some habitats by vegetation management which prolongs early stages of plant succession. Wildlife requiring open areas is displaced as young stands age, especially in alterntives A and B.

4. Threatened, Endangered, Proposed, and Sensitive Species

Lack of vegetation management in alternative A reduces populations or prevents recovery of some animals and plants that can exist only in forests experiencing periodic disturbances.

5. Soil

Soil productivity is impaired where methods cause excessive loss of soil organisms, organic matter, and nutrients in alternatuves F and H.

6. Water

Water quality is impaired in some small streams in watersheds experiencing widespread use of high disturbance tools in alternatives F and H.

7. Air Quality

Smoke from prescribed fires or wildfires temporarily impairs air quality in every alternative.

8. Rights-of-Way

Lack of treatment in alternative A allows vegetation to encroach on rights-of-way, threatening public safety on roads and trails and impairing operation of utility corridors.

9. Visual Quality

Visual quality is temporarily impaired by vegetation management methods. Lack of treatment in alternatives A and B may also cause impairment.

10. Wildfire

Lack of prescribed fire in alternative A and limited use in alternative B allow fuels to build to dangerous levels and increase probability and severity of wildfire damage.

11. Socioeconomic Conditions

Any action or lack of action is acceptable to some people and unacceptable to others. This disagreement creates social conflict about vegetation management. Conflict is created whenever there are changes from current ways of doing things.

S. IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

An irreversible commitment is one in which nonrenewable resources are permanently lost. Such losses occur because oil, gas, coal, or petroleum products are consumed and cannot be replaced. Some endangered plants occurring only on national forests may be irreversibly lost in alternative A. Soil productivity may be impaired for many decades on sites where raking or severe slash burns are used in alternatives F and H.

An irretrievable commitment is one in which resource production or use is lost while managing an area for another purpose. If we choose not to manage a resource, we do so knowing we lose its potential value had it been managed. All alternatives eliminate or reduce management of some resources, while emphasizing others.

T. SHORT-TERM USES AND LONG-TERM PRODUCTIVITY

National forests must be managed to protect long-term productivity of the land. Long-term productivity is the capability of forests to provide resources into the future. Most management activities and resource outputs are short-term uses. When decisions are made to produce these outputs, long-term productivity could be affected. Generally, management requirements and mitigation measures reduce or eliminate effects on long-term productivity by protecting resources like soil, water, wildlife, threatened and endangered plants and animals, and visual quality.

Monitoring requirements which apply to all alternatives, ensure that long-term productivity is not impaired by short-term uses. If monitoring discloses that management requirements and mitigation measures are inadequate, new ones will be developed.

List of Preparers

CHAPTER V

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LIST OF PREPARERS

A. INTERDISCIPLINARY TEAM SELECTION

The Regional Forester and his staff evaluated the need to prepare an environmental impact statement and identified activities which needed to be analyzed. Once analysis needs were known, a team leader was selected and the team leader and Regional Forester looked at the Region's work force to locate individuals with education and experience necessary to complete the analysis.

Team members listed below represent a broad mix of experience and specialized training. Specialties cover a wide range of resources and all members are highly experienced in natural resource and human resource management. The team prepared this EIS. Some of the work they did was identifying and examining issues, developing and evaluating alternatives, researching and analyzing environmental effects, and studying and responding to public comments.

B. FULL-TIME TEAM MEMBERS

Steve McCorquodale is the team leader. He has a Bachelor of Science degree in Forestry from McNeese State University at Lake Charles, Louisiana. Steve is completing his 23rd year with the Forest Service and has had assignments in North Carolina, Texas, Virginia, Mississippi, Kentucky, Alabama, and Georgia. His principal area of expertise is in fire management, in addition, his positions have given him responsible administrative and supervisory experience in recreation, silviculture, public affairs, minerals, and wilderness. Steve is an avid hunter and fisherman and pursues his interests in natural resources through active memberships in Society of American Foresters and Alabama Forestry Association.

Interdisciplinary Team responsibilities include overall management and supervision as well as coordination with others and accountability to management.

Ann Cason is the program assistant. She has specialized secretarial education through several Office of Personnel secretarial, business management, and administration courses. Ann is completing her 24th year of Federal service and has had assignments with the Environmental Protection Agency, Department of Justice, U. S. Geological Survey, Department of Defense, and for the last eight years with the Forest Service. Assignments in positions such as administrative technician, clerk-stenographer, secretary, and executive secretary have given her broad administrative experience. Ann enjoys gardening and walking.

Her responsibilities on the team include internal and external scheduling, correspondence, computer management, financial management and travel.

Jim Maxwell is the team hydrologist. He has a Bachelor of Science degree in Forest Hydrology from Utah State University at Logan, Utah. Jim is completing his 17th year with the Forest Service and has had assignments in California, Utah, Idaho, West Virginia, Oregon, New Mexico, and Georgia. His principal area of expertise is in streamflow-sediment dynamics. In addition his positions have given him supervision and administration experience in stream and fisheries protection, rainfall-runoff relationships, and influence of climate. Jim is an avid hiker and river floater.

Responsibilities as a team member are for analysis of soil, water and air resources and evaluation of cumulative effects.

Paul A. Mistretta is the team plant pathologist. He has a Bachelor of Science degree in Biology from Fordham College, New York, New York, a Master of Forestry degree (forest protection) from Duke University, Durham, North Carolina, and a Doctor of Philosophy in plant science from the University of Maine at Orono. Paul is completing his 11th year with the Forest Service and has had assignments in Georgia and Louisiana. His principal area of expertise is in epidemiology of forest tree diseases. He also has two years experience as a graduate teaching assistant. He has authored or coauthored over 40 publications and is active in several professional societies. Paul enjoys philately and computer programming.

Responsibilities as a team member are for coordination of risk assessment, toxicology and rights-of-way analyses and incorporation of those analyses into the EIS.

Jane Sell is the editorial assistant. She has enhanced her skills through on-the-job training. Jane is completing her 15th year with the Forest Service and has had assignments as clerk-typist and clerk-stenographer. Her experience as owner-operator of a printing company for 12 years and additional administrative-editorial experience with other environmental documents with the Forest Service give her broad qualifications. Jane actively pursues outdoor sports.

Team support responsibilities are to manage filing and data systems, assist with edit and layout, and to coordinate literature search.

Gary Sick is the team public affairs specialist. He has a Bachelor of Science degree in Geological Sciences from the State University of New York at Geneseo, New York and a

Master of Science degree in Forestry (policy analysis) from Michigan State University at East Lansing, Michigan. Gary is completing his 10th year with the Forest Service and has had assignments in Mississippi, Arkansas, Michigan and Georgia. His principal area of expertise is in minerals management. In addition, his positions have given him responsible management experience in data management, environmental planning, and water quality analysis. Earlier experience includes three years in social work and one year in public schools. Gary enjoys most outdoor recreation, especially fishing.

Responsibilities on the team are NEPA compliance, scoping, media and document production.

Cynthia A. Witkowski is the team silviculturist. She has a Bachelor of Science degree in Natural Resource Conservation from the University of Connecticut at Storrs, Connecticut. Cindy is completing her 9th year with the Forest Service and has had assignments in South Carolina, Arkansas, Louisiana and Georgia. Her principal area of expertise is in timber and silviculture. Her positions have also given her responsible management experience in administration, recreation, minerals, wildlife and human resources. Two years with the Peace Corps also gave her broad natural resource management skills. Cindy enjoys golf and fishing and has active memberships in the Society of American Foresters.

Team responsibilities are analysis and coordination of silviculture, wildlife and range.

C. PART-TIME TEAM MEMBERS

Joel Artman is a team member from the Virginia Department of Forestry. He attended the University of Tennessee; received a Bachelor of Science degree in Forest Management from North Carolina State University and a Masters degree from Duke University in Forest Pathology. Joel has been with the Virginia Department of Forestry for about 25 years and currently occupies the position of Chief of the Pest Management Branch. One of his primary duties involves the operational and testing efforts in chemical site preparation and pine release for the Department's pesticide programs. He enjoys crocheting and woodworking during the winter, while summer's spare time is occupied canoeing, camping, and messing with snakes.

Part-time responsibilities include input and review for herbicide use, aerial application and liaison with Southern Group of State Foresters.

Edwin H. Barron has a Bachelor of Science degree in Forestry from Louisiana Polytechnic University at Ruston, Louisiana, and a Master of Forestry degree from Stephen F. Austin State

University at Nacogdoches, Texas. Ed is completing his 22nd year with the Texas Forest Service. His principal area of expertise is forest management and program administration. In his current position as head of the Forest Management Department, he is responsible for providing overall direction, planning and administration for the agency's forest management and pest control programs. He serves as a principal staff officer to the Director of the Texas Forest Service. He remains active in memberships in the Society of American Foresters and the Texas Forestry Association.

Responsibilities as a team member are providing technical advice and reviewing alternatives for vegetative management practices.

Jim Fenwood is the team wildlife biologist. He has a Bachelor of Science degree in Wildlife Management from the University of Maine at Orono, Maine, and a Master of Science degree in Wildlife Management from West Virginia University at Morgantown, West Virginia. Jim is completing his tenth year with the Forest Service and has had assignments in Arkansas and South Carolina. His principal area of expertise is forest wildlife management. In addition his positions have given him responsible management experience in fire, range, watershed, and recreation. Jim is a Certified Wildlife Biologist and active member of the Wildlife Society, National Audubon Society, and other conservation organizations. He enjoys outdoor writing, photography, and hunting.

Team responsibility is for analysis of effects on wildlife habitat and on threatened, endangered and sensitive species.

Richard Greenhalgh is the Southern Region's economist, and provided economic analysis support on a part-time basis. He has a Bachelor of Science degree in Vocational Education and a Master of Science degree in Agricultural Economics from University of Nebraska, and a Doctor of Philosophy with emphasis in Natural Resource Economics from the University of Missouri. His experience includes 15 years of research and river basin studies throughout the Southeast with the USDA Economics Research Service, and eight years as an economist with the Forest Service.

Gerald Helton is the team sociologist. He has a Bachelor of Arts degree in Psychology from Morehouse College, Atlanta, Georgia, and the Master of Arts degree in Social Service Administration from the University of Chicago, Chicago, Illinois. Gerald is completing his 12th year with the Forest Service and has worked in Atlanta, Georgia during that period. He has earlier experience working for three years for the City of Atlanta as an Employment Counselor. Gerald's principal area of expertise is in management/

supervisory training. He also has experience in team building and group dynamics. He enjoys reading, photography, and spectator sports and is an active member of Toastmasters International.

Responsibility as a team member is for social analysis.

Jerry Lee Michael holds a B.S. in chemistry from Elon College (1966), master's degree in plant taxonomy from the University of North Carolina at Chapel Hill (1969), and a Ph.D. in tree physiology from Colorado State University (1974).

He has spent two years in the army (1969-1971) as a plant physiologist at Fort Detrick, Maryland. After completion of the Ph.D. at Colorado, he went to the University of Georgia as a post-doctoral fellow where he worked on host-physiology related aspects of the southern pine beetle problem and on the physiology of paraquat induced resin soaking in southern pines.

He is currently employed by the Southern Forest Experiment Station, Forest Service at Auburn University, Auburn, Alabama. His primary work has been research on environmental chemistry of the principal herbicides used in forestry including the immediate and ultimate fate of herbicides applied to forest ecosystems. Responsibilities as a part-time team member are for analysis and evaluation of herbicide effects.

Dan Neary is the team soil scientist. He has a Bachelor of Science degree in Forestry, a Master of Science degree in Forest Ecology, and a Doctor of Philosophy degree in Forest Soils and Hydrology, all from Michigan State University at East Lansing. Dan is completing his 10th year with the Forest Service. He has had assignments with the New Zealand Forest Research Institute and the Cowetta Hydrologic Laboratory, North Carolina, and is currently part of the Intensive Management Practices Assessment Center, Southeastern Forest Experiment Station at the University of Florida. His principal area of expertise is in the environmental fate and effects of forestry pesticides, but he also has considerable experience with the effects of intensive forestry on soils, site productivity, and water quality. He has authored or co-authored over 65 publications, and is active in numerous scientific organizations. Dan enjoys swimming, sailing, and skiing.

Responsibilities as a part-time team member are for analyses and evaluation of herbicide effects, soil and water impacts, and cumulative watershed effects.

Dennis Robertson has a Bachelor of Science degree in Landscape Architecture from the University of Missouri at Columbia, Missouri. He is completing his 21st year with the Forest Service with assignments in Washington, Wyoming, Arkansas, and Georgia. His principal area of expertise is in resource planning and in addition his assignments have given him responsible management experience in recreation management, facilities design, landscape management, and rights-of-way design.

Dennis enjoys many outdoor sports and yard work, and maintains an active membership in the National Arbor Day Foundation.

Responsibilities as a team member are for analysis of visual quality and rights-of-way maintenance techniques.

Max Williamson is the Regional Pesticide Specialist. He has a Bachelor of Science degree in Chemistry from Cumberland College at Williamsburg, Kentucky, and the Master of Science degree in Environmental Engineering from Murray State University at Murray, Kentucky. He has completed additional graduate studies in Physical Sciences and Toxicology. He is completing his 25th year with the Forest Service and has broad experience as a pesticide specialist and resource management. His assignments have been in California, Virginia, North Carolina, Arkansas, Oklahoma, and Georgia.

Responsibility as a team member is to serve in an advisory capacity, and to act as liaison with industry and regulatory bodies.

Tom Wiseman is a writer-editor with the team. He has a Bachelor of Arts degree in English from the Pennsylvania State University at University Park, Pennsylvania. He also earned a Master of Arts and a Ph.D in English from Tulane University in New Orleans, Louisiana. He served as writer-editor with the Forest Service's Southern Forest Experiment Station for 2 years. Additionally, he edited *Forest Farmer* magazine for 8 years He is now assistant professor of English at Southern College of Technology in Marietta, Georgia. Tom enjoys fishing, coaching youth basketball, and creative writing.

Team responsibilities include copy editing and writing, assisting with layout and design, and proofreading.

D. ADVISORS, CONSULTANTS AND REVIEWERS

1. Advisors

Stanford Adams, USDA Forest Service, Public Affairs
Larry Bishop, USDA Forest Service, Coop Forestry

Steve Dornseif, USDA Forest Service, Systems Supp
Chris Glover, USDA Forest Service, Systems Support
Harold Greenlee, USDA Forest Service, Geometronics
Douglass Hattersley, USDA Forest Service, Lands and M
Jimmy Huntley, USDA Forest Service, Fisheries and Wild
Jean Kruglewicz, USDA Forest Service, NEPA Compliance
Jim Lunsford, USDA Forest Service, Fire
Keith McLaughlin, USDA Forest Service, Soil, Water and
Bob Stignani, USDA Forest Service, Recreation
Jimmy Walker, USDA Forest Service, Timber/Silviculture

2. Risk Assessment Review

Joanne E. Betso, Dow Chemical USA
Jim Brewer, JLB International Chemicals
Sean Casey, Elanco Products
Dave Clapp, Centers for Disease Control
Bob Cooke, USDI Fish and Wildlife Service
Edwin Dale, Private citizen
Ed Daley, International Paper
Tom Darden, USDA Forest Service
Dean Gjerstad, Auburn University
Jack Gnegy, Westvaco
Larry Gross, USDA Forest Service
Simon K. Hall, American Cyanamid
Zdenka Horakova, USDA Forest Service
George Hurst, Mississippi State University
Kentucky Power Co.
Kentucky Utilities Co.
Timothy J. Long, Montsanto Co.
Bob Lowery, Weyerhaeuser
Bill McComb, Oregon State University
Jerry L. Michael, USDA Forest Service
Hans Muller, US Environmental Protection Agency
Fredrick O. O'Neal, E.I. Dupont Co.
Bill Pope, Potlach
John Taylor, USDA Forest Service
Shep Zedacker, Virginia Polytechnic Institute

3. Technical Consultants and Review

Richard Ames, USDA Forest Service
Thomas M. Armitage, US Environmental Protection Agency
W. Wilson Baker
Cathy Bowman, USDA Forest Service
Ed Buckner, University of Tennessee
Bill Carothers, USDA Forest Service
Andre F. Clewell
Jerry Clutts, USDA Forest Service
Art Cram, Private citizen
George Dissmeyer, USDA Forest Service
Ronald Eislor, USDI Fish and Wildlife Service
Eric Ellwood, North Carolina State University
Ron Escano, USDA Forest Service
Roger Fryar, USDA Forest Service
Glen Glover, Auburn University
Robert K. Godfrey, Florida State University

Paul Hamel, Tennessee Department of Conservation
Dennis Harden, Florida Natural Resources Inventory
Jim Harrison, US Environmental Protection Agency
Gary Hasty, Tennessee Valley Authority
Isaac W. Hawkins, USDA Forest Service
John Hosner, Virginia Tech.
W. Wayne Johnson, USDI Fish and Wildlife Service
Bill Jones, Alabama Forestry Assoc.
Dave Ketcham, USDA Forest Service
Ken Knauer, USDA Forest Service
Larry Landers, Tall Timbers Research Station
Gary Larsen, USDA Forest Service
Carlton R. Layne, US Environmental Protection Agency
Clifford Lewis, USDA Forest Service
William Mahan, SCWMRD
Brandt Manchen, City of Houston
Gene McGee, USDA Forest Service
Bill McKee, USDA Forest Service
Charles McMahon, USDA Forest Service
Bruce Means
Edwin Michael, West Virginia University
Patrick J. Minogue, Auburn University
Bob Mitchell, Auburn University
Logan Norris, Oregon State University
Max Ollieu, USDA Forest Service
Jim Paul, USDA Forest Service
Henry Pearson, USDA Forest Service
Steve Price, National Park Service
Jerry Ragus, USDA Forest Service
David Saugey, USDA Forest Service
Jesse T. Simmons, Tennessee Valley Authority
Rhey Solomon, USDA Forest Service
Peter Sprints, Texas A&M
Peter Swiderek, SCWMRD
Benee Swindel, IMPAC, University of Florida
Richard Tallent, Tennessee Valley Authority
Ronald Thill, USDA Forest Service
David Van Lear, Clemson University
Dale Wade, USDA Forest Service
Tom Wojtalik, Tennessee Valley Authority
Tom Welborn, US Environmental Protection Agency
Carol Wells, USDA Forest Service
Carl S. Wilhelm, Jr., USDA Forest Service
Dale Wilhelm, Tennessee Valley Authority

Public Participation and Consultation With Others

CHAPTER VI

CHAPTER VI

PUBLIC PARTICIPATION AND CONSULTATION WITH OTHERS

A. PUBLIC INVOLVEMENT SUMMARY

Because vegetation management issues are often intense and sometimes emotional, a high level of public participation was deemed necessary for satisfactory completion of this environmental impact statement. Therefore, the public has been actively involved in its development. Many people and organizations made valuable contributions to the analysis.

The Forest Service has encouraged public participation throughout EIS preparation. Steps taken to keep the public informed and involved are:

Notice of Intent - A notice of intent to prepare this EIS was published in the September 11, 1986 Federal Register. A revised Notice of Intent, based on early scoping results, was published in the May 5, 1987 Federal Register. This revision described methods which would be evaluated, dates for public review of the draft statement and the completion date for the final statement.

Letter to the Public - The public was asked to identify issues through the use of a post-paid mailer designed for this project. Over 11,000 of these mailers were distributed to interested individuals, groups and agencies in January 1987. To obtain the broadest possible coverage, each forest assembled a list of every party known to them to be interested in national forest management. These lists were then merged into a master list.

Media - Radio, television and the press were included in the request for comments on issues. Additionally a press release was distributed: to regional media by the Regional Public Affairs Office, and to state and local media by individual Forest Public Affairs Offices. The press release was done at the same time as mailers were sent, January 1987.

Meetings - On several occasions between January and August 1987 members of the interdisciplinary team and designated forest representatives met or spoke with agencies, organizations and individuals whenever the level of interest was appropriate for this type activity. Needs varied from locality to locality with Texas, Florida and Georgia showing the most intense interest.

Tabloid - In May 1987, 6000 tabloids containing information about the scope, timing and progress of the EIS were distributed. Also included in the tabloid were articles about issues, alternative themes, risk assessment, and some methods proposed for use. A post-paid return envelope was inserted in the tabloid to allow for additional public response. A coupon requesting a copy of the EIS or just inclusion on the mailing list was also printed to offer an opportunity to anyone who might not have already made the request.

Key Contacts - Other Federal agencies, Congressional delegations, State agencies, State lawmakers, other Forest Service Regions, and heads of organizations were contacted by phone and by letter to inform them of project initiation. Accompanying the letter was an informational brochure describing the scope of the EIS and responding to commonly asked questions.

Risk Assessment - Recognizing that the risk assessment is a technical document with complex thoughts and analysis, postal cards were mailed to all respondents offering them an opportunity to request a draft risk assessment for review. This mailing was done during August and September 1987. About 35 percent of the addresses desired review copies.

Cooperators - No other Agencies requested formal cooperator status, though many were consulted and contributed to the analysis. A unique form of cooperation was implemented for the risk assessment. Other State and Federal agencies as well as several utility companies were offered an opportunity to expand the scope of the risk assessment (to evaluate additional herbicides used by them on their easements or permit areas on national forests). To do this they were required to fund the additional costs of analysis. Eleven utilities and the Tennessee Valley Authority elected to participate.

Responses - Public responses to the request for input on issues were catalogued into nine categories: elected officials; State and local government; Federal government; individuals; organizations; businesses; Forest Service employees; Forest Service retirees; and media. At the time of content analysis, March 1987, 813 responses had been received from 27 states and the District of Columbia. (See table VI-1 for a complete breakdown). Ultimately, the total number of responses was 891.

Of the 813 responses in the table, 756 or 92 percent came from states within the geographic area covered by this EIS. Based on a comparison between the number of contacts and number of responses, the most intense response came from Texas and Florida.

Table VI-1.--Response distribution - Coastal Plain/Piedmont.

State	Category Elec Off.	St./Loc Gov't	Fed. Gov't	Indi-viduals	Organi-zations	Busi-nesses	Employ-ees	Retir-ees	Media	Total
Alabama		8	2	51	6	6	6			79
Arkansas				4	3	1		2		10
Arizona				1				1		2
Colorado					1		1			2
Florida		17	1	48	17	13	11		3	110
Georgia		6	2	13	8	3	10	7		49
Kentucky				1		1				2
Louisiana		5	3	42	10	12	7			79
Michigan							1			1
Minnesota				1						1
Mississippi	1	7	1	41	7	10	6		1	74
Missouri						1				1
Montana					1					1
New Hampshire				1						1
New Jersey						1				1
New Mexico								1		1
New York				3						3
North Carolina		14	3	105	14	4	2	2	4	148
Ohio				2						2
Oklahoma			1	3						4
Oregon				1			1			2
Pennsylvania				2						2
South Carolina		3		21	5	6	2	5	1	43
Tennessee			1	1	1			2		5
Texas	1	8	6	123	15	14	6		1	174
Virginia			1	4	2	1		3		11
West Virginia			1							1
Washington, DC			2		2					4
Total	2	68	24	468	92	73	53	23	10	813

To improve responsiveness and to enhance the analysis, working papers and partial drafts of many parts of the EIS were shared with cooperating agencies, working groups and citizens with special expertise throughout the process.

Scientific adequacy was ensured through an extensive system of review. Chapter V, D. lists reviewers and their affiliations. Unique qualifications of these people augment disciplines represented on the interdisciplinary team.

Responses were organized into about 150 groups based on methods and affected resources. These groups were then analyzed for major themes called issues (chapter I). Then, a number of alternatives (chapter II) were developed which were responsive to these issues.

The next step in public review is distribution of the draft statement. Copies are sent to each of the 891 respondents as well as additional persons known to have an interest or required by regulations (chapter VI, part C).

B. CONSULTATION WITH OTHERS

One of the most important parts of the process of preparing this environmental impact statement is information gathering. Advice and contributions from experts are essential to a thorough and complete analysis. Chapter V lists nearly one hundred individuals who contributed. Additionally, in many cases authors of research papers were consulted to clarify results of their analyses.

While all consultations helped shape the analysis contained in this document, some consultations resulted in specific significant direction on how to conduct the analysis.

Offices of the Environmental Protection Agency in Atlanta, Georgia and Washington, D.C. were consulted concerning analysis requirements, especially for water. They advised that cumulative effects be analyzed on typical, representative watersheds. They also advised that analysis of sediment loads consider potential effects on quality of fish habitat. The analysis in chapter IV models cumulative watershed effects as advised, and considers effects on fisheries.

Dow Chemical Company was consulted regarding the results of new tests on dermal penetration rates for triclopyr. These test results caused substantial revision of risk assessment.

The contractor responsible for preparation of the risk assessment, Labat-Anderson, Inc., routinely consulted with the Environmental Protection Agency regarding analytical protocol for the risk assessment, and to obtain toxicological information. Data resulting from these consultations are reflected in the risk assessment.

C. LIST OF THOSE TO WHOM THIS DOCUMENT WAS SENT

<u>Businesses</u>

Adley Associates
Ahimsa Techni
Alabama Power
Amerada Hess
American Cyanamid

Anderson Manufacturing
Appalachian Power
AR Consultants
ARK Land Co.
Arkansas Louisiana Gas
Arkansas Power & Light
Asplundh Tree Expert
Balfour Pulpwood
Barc Electric
Boise Cascade
Boston Edison
Buckeye Cellulose
Canal Wood of Fitzgerald
Carolina Wilderness Adventures
Bobby Cauley, Inc.
Central Alabama Electric
Central Louisiana Power
Central Virginia Electric
Champion International
Cities Service Oil and Gas
Conoco
Curtis Land Co.
Dixie Electric Power
Dixie Pipeline
Dow Chemical
East Kentucky Power
Elanco Products
Environmental Services
Estate of Wm. G. Helis
Fairfield Electric
Florida Power
Gee & Jenson, Inc.
Georgia Pacific
Georgia Power
Georgia Timberlands
Gulf States Utilities
John G. Guthrie & Sons
Hankins Lumber
Helena Chemical Co.
A. J. Hodges, Inc.
International Paper
ITT Rayonier
Joe Jacobs Insurance
Kentucky Power
Kentucky Utilities
Fred King Hunting Ranch
Leaf River Forest Prod.
Louisiana Pacific
Mansville Forest Prod.
Roy O. Martin Lumber
Mims Wood
Mississippi Power & Light
Mobile Pipeline
Monongahela Power
Monsanto
Morton Manufacturing
MS Title Service
Munro Petroleum Terminal
Owens Illinois
Potlach
Potomac Edison
Powell Industries
Hubert Pelley Marine Sales
Resource Management Service
Rocko Electric
Sam Houston Electric
SC Electric & Gas
Shenandoah Valley Electric
Sibley Lake Realty
Southwest Forest Industries
St. Joseph Land Development
Summit Helicopters
Sumter Electric
Tennessee Gas Pipeline
Texas Utilities Electric
Valley Nursery
Virginia Power
Wainwright Engineering
Warmack Lk.
Weaver Land and Timber
Westvaco
Weyerhaeuser
Willamette Timber

Colleges and Universities

Alabama A&M
Alcorn State, MS
Auburn, AL
Clemson, SC
Delaware State
Duke, NC
Florida A&M
Fort Valley State, GA
Furman, SC
Harvard, MA
Humboldt State, CA
Kentucky State
Langston, OK
Lincoln, MO
Louisiana State
Louisiana Tech
Mississippi State
Natchitoches State, LA

North Carolina A&T
North Carolina State
Northwestern, IL
Oklahoma State
Prarie View A&M, TX
Roanoke, VA
Rust, MS
Slippery Rock State, PA
South Carolina State
Southern LA
Southern Mississippi
Stephen F. Austin, TX
Tennessee State
Texas A&M
Tuskegee Institute, AL
University of Alabama
University of Arkansas
University of Florida
University of Georgia
University of Houston, TX
University of Kentucky
University of Maryland
University of North Carolina
University of Pittsburg, PA
University of Tennessee
University of Washington
University of Wisconsin
Virginia Polytechnic Institute
Virginia State
Western Carolina, NC
West Georgia
West Virginia
Yale, CT

<u>Elected Federal Officials</u>

Alabama
- Howell Heflin
- Richard C. Shelby
- Tom Bevill
- Sonny Callahan
- Bill Dickinson
- Ronnie Flippo
- Claude Harris

Florida
- Lawton Chiles
- Bob Graham
- Bill Chappell, Jr.
- Bill Grant
- Earl Hutto
- Buddy MacKay
- Bill McCollum

Georgia
- W. Wyche Fowler, Jr.
- Sam Nunn
- Charles F. Hatcher
- Pat Swindall
- John R. Lewis
- George W. Darden
- J. Roy Rowland
- Ed Jenkins
- D. Douglas Barnard

Louisiana
- J. Bennett Johnston
- John B. Breaux
- Charles E. Roemer
- Jerry Huckaby
- Clyde Holloway

Mississippi
- Thad Cochran
- John C. Stennis
- Wayne Dowdy
- Mike Espy
- Trent Lott
- G. V. Montgomery
- Jamie Whitten

North Carolina
- Jesse Helms
- Terry Sanford
- Walter Jones
- David E. Price
- Stephen Neal
- W. G. (Bill) Hefner
- Cas Ballenger
- James McClure Clarke

South Carolina
- Ernest F. Hollings
- J. Strom Thurmond
- Butler C. Derrick, Jr.
- Elizabeth J. Patterson
- Arthur Ravenel, Jr.
- Floyd D. Spence
- John M. Spratt, Jr.
- Robert M. Tallon, Jr.

Texas
- Lloyd Bentsen
- Phil Gramm
- Joe Barton
- Jim Chapman
- Ralph M. Hall
- Charles Stenholm
- Charles Wilson

Federal Agencies

Advisory Council on Historic Preservation - Washington, DC
Centers for Disease Control - Atlanta, GA
Delaware River Basins Commission - NJ
Department of Agriculture
- APHIS - Hyattsville, MD
- Office of Equal Opportunity - Washington, DC
- Office of the General Counsel - Atlanta, GA - Ogden, UT - Washington, DC
- Office of the Secretary - Washington, DC
- Rural Electrification Administration - Washington, DC
- Soil Conservation Service - AL, FL, GA, LA, NC, TX, Washington, DC

Department of Commerce
- National Marine Fisheries Service - FL
- National Oceanic & Atmospheric Administration - Washington, DC

Department of Defense
- Department of the Air Force
  - AFRCE-CR/ROV - TX
- Department of the Army
  - Fort Polk
  - Corps of Engineers - Mobile, AL - Washington, DC
- U.S. Marine Corps
  - Camp LeJeune

Department of the Interior
- Bureau of Land Management - Alexandria, VA
- Bureau of Mines - Washington, DC
- Fish and Wildlife Service - Annapolis, MD - Asheville, NC - Atlanta, GA - Fort Worth, TX - Nacodoches, TX - Raleigh, NC
- Geological Survey - Tuscaloosa, AL
- National Park Service - Daviston, AL - Gatlinburg, Tn - Harpers Ferry, WV - Louisville, KY - Philadelphia, PA - Tupelo, MS
- Office of Environmental Review - Albuquerque, NM - Washington, DC
- Office of Surface Mining - Washington, DC

Department of Transportation
- Federal Highway Administration - Atlanta, GA - Baltimore, MD - Baton Rouge, LA - Columbia, SC - Fort Worth, TX - Tallahassee, FL

Environmental Protection Agency - Atlanta, GA - Dallas, TX - New York, NY - Philadelphia, PA - Washington, DC
Equal Employment Opportunity Commission - Washington, DC
Federal Energy Regulatory Commission - Washington, DC
General Services Administration - Washington, DC
National Endowment for the Arts - Washington, DC
Occupational Safety & Health Administration - Washington, DC
Small Business Administration - Atlanta, GA
Southwestern Power Administration - OK
Tennessee Valley Authority - TN

Individuals

Abernathy, Wilford, L.
Adams, John A., Jr.
Adams, John A.
Adams, David A.
Adams, Reginald D.
Aery, Dorothy
Ahearn, Walter T.
Alexander, William H.
Alfiero, Richard
Allbritton, Robert M.
Allen, Arthur
Allison, Jim
Allred, George E.
Ambuske, Robert F.
Anderson, C. E.
Anderson, Charles
Arinder, Clifton L.
Armentrout, Bob
Arnbal, Anders K.
Arner, Dale
Arnold, Edward E., Sr.
Arrowood, Cathy
Arthur, Giles B.
Ayers, James W.
Bailey, Tommy L.
Baker, Alen D.
Baker, James
Baker, Robert D.

Baker, Scottie
Balboni, Michael L.
Baldridge, Dave
Baldwin, John
Baltie, Tony J.
Baranski, Michael J.
Barden, Larry
Barefoot, Charles A.
Barker, Milton E., Jr.
Barnes, Sam
Barnette, Phil
Barr, Thomas C., Jr.
Barrett, Willie W.
Barrett, Jerry
Bass, Stuart
Bates, Richard J.
Battle, Oscar K., Jr.
Baxter, Norman W.
Beachy, Paul
Belangia, C. O.
Bennett, N. I.
Bennett, Nancy M.
Bennett, Ralph M.
Besold, Henry
Bethancourt, Don
Billetdeaux, Susan H.
Bingham, Hoyle
Birch, Harold B.
Blackwell, Charles W.
Blaine, Ray
Bolt, Martin G.
Booth, Carl
Boothby, Johnson
Borders, Gene
Boswell, L. G.
Bounds, John H.
Bousquet, Woodward S.
Bowling, Dale Ray
Boyce, Stephen G.
Bezanson, Janice
Brabham, Robert
Brantley, Christopher G.
Brantly, Robert M.
Braun, Ron
Bray, Earl
Bray, Jack
Breazeale, Jimmy Riley
Breland, Keith A.
Brevelle, Carl J.
Bridges, R. L.
Brimberry, Kate E.
Brinson, Robert
Broussard, Allan J.
Brown, F. H.
Brown, Angus
Brown, M. J.
Brugger, Kristin
Bruner, Marlin H.
Bryan, Dana C.
Buckner, James V.
Burkart, David
Burkes, Danny L.
Burnett, Howard
Burns, Anna
Byrd, Nathan A.
Cain, Jimmy D.
Caire, Michael J.
Callahan, Jack N.
Cameron, Viola M.
Carnes, James T.
Carnes, Sandy
Carpenter, Janella Ann
Carpenter, Douglas M.
Carr, Majorie
Carroll, Wayne D.
Cartwright, James B.
Cartwright, Alfreddie
Cartwright, T. C.
Cascio, Gary
Cason, Randy W.
Cassell, Howell
Chambliss, Erwin B.
Chang, M
Charest, Bert
Chumbley, Lola
Chumbley, Mose
Cibula, William
Clark, Brian
Clement, D. A.
Clewell, Andre F.
Coleman, Lee
Collom, Ralph M.
Colvin, Thagard R.
Compton, Glenn
Connor, Buddy W.
Conner, Richard N.
Conner, Bob
Conner, Elizabeth
Cooper, Jerome
Cornelius, Don
Covington, James R.
Cristman, Steve
Crockett, George
Cunningham, Peyton, Jr.
Cunningham, M. L.
Curry, Mary G.
Curtis, Robert L.
D'Oriocourt, Bryan
Daland, Robert T.
Dale, Edwin
Daley, Ed
Darnell, Donnie
Davenport, Bruce C.
Davenport, Sandy
Davids, H. E.
Davidson, Jib A.
Davis, Anse Mack
Davis, E. L.
Davis, Jerry W.
Davis, Joel Henry
Dawson, James C.
Debrunner, L. Earl
Decker, George R.
Delemar, James C.
Devall, Margaret S.
Diblick, A. V.
Dickey, W. M.
Dillahunt, Dennis D.
Dixon, Bob
Dockery, Alex
Dooley, James E.
Dougherty, Phillip M.
Draper, Harold
Drumheller, Philip M.
Drummond, Margaret
Dudley, George W.
Duffy, Roberta M.
Dunn, B. Allen
Dutrow, George
Dwinell, Steven E.
Earnest, J. Chris
Edmondson, Edwin W.
Edmonson, Joseph
Edwards, Malcolm G.
Elam, Bob
Elliott, R. P.
Ellis, David
Elsen, Dean
Elsner, Norman R.
Emery, Edith A.
Epperly, Sheryan P.
Ernst, Charles F.
Erwin, Kevin L.
Evans, John
Evans, Azilda
Evans, Michael
Evans, S. B., Jr.
Ewald, William
Ewel, Katherine

Fanning, Marsha E.
Farmer, Jerome
Fayard, Henry M.
Ferguson, Clyde A. B.
Fieselman, C.
Finch, Ray E.
Findley, Frank
Fish, Herb
Fitzmayer, Bob
Flake, Harold W.
Fleming, Johnny
Fletcher, John M.
Fondren, Matt
Forbes, Donovan C.
Forsythe, Tom
Fort, E. B.
Foster, Williams S.
Fountain, Michael S.
Fowler, Ian K.
Fowler, Norma L.
Fowler, Thomas
Fox, Walter
Franks, Douglas
Fraser, Thomas E.
Friedrich, Allan
Frye, Mrs. Russell
Fulgham, Charlie B.
Gaddy, L. L.
Gaitanis, Louis A.
Galloway, Joe C.
Galsby, Roswell P.
Gardner, Joel
Gardner, William
Garrett, L. M.
Gault, William J.
Gay, Julian D.
Gaydosh, Robert J.
Geisendorff, Nathan E.
Geisler, James C.
Gerry, Bob
Gist, Howard B., III
Gnegy, Jack
Goertz, John W.
Goodyear, Bob
Gowan, Claude A.
Graham, Dick
Graham, Charles
Graham, Michael
Graves, A. L.
Greer, John L.
Gregas, Norman P.
Gregory, James D.
Griffith, Edith M.
Griffith, Robert L.
Griffitt, Keith
Grimm, B. A.
Grushinski, Ed
Guthrie, J. William
Hagler, Chris
Hair, J. D.
Hale, John C.
Haley, Curtis R.
Hall, Ralph E.
Hallman, Ronnie
Hamann, Richard
Hamilton, John M.
Hancock, G. Nicholas
Hansbourough, Thomas
Hardin, John D.
Hardy, Ray
Hargraves, L.
Harman, Jerry E.
Harper, George Lea, Jr.
Harris, Finis L.
Harrison, Jack A.
Hart, Robin
Hartfield, Paul
Hartman, John
Hasty, Gary
Haviland, R. P.
Hawk, Robert T.
Hawkins, W. Michiel
Hayes, Lark
Haygreen, James H.
Healy, Tom
Hehr, B.
Heiland, Sharyn
Hendler, Richard J.
Herbert, Allen
Herman, Richard
Hess, William
Hiers, R.
Hightower, Fred
Hihn, Don E.
Hill, Peggy
Hill, Isaiah
Hill, Robert W.
Hilliard, John R.
Hinchee, Janet K.
Hinkle, Robert C.
Hitt, James
Hodges, Donald Glenn
Hodges, John D.
Hoelscher, James E., Jr.
Hogan, Joe
Holcombe, Edwin F.
Hollander, Alex
Holler, Gary W.
Hollingsworth, Paul
Hollinsworth, Natalie J.
Hopenwasser, Alan
Hopkins, Wesley
Horakova, Zdenka Z.
Horton, Billy R.
Hosner, J. F.
Hotvedt, J. E.
Hough, Marshall J.
Howard, H. E.
Howard, Donna B.
Howard, Jack A.
Hugh, J. A.
Hughes, Rickey E.
Humphrey, David
Hunter, Jeff
Hutchens, James B., Jr.
Hutchison, Inge S.
Hyder, Brian
Imhof, Thomas
Imhof, John Michael
Irwin, John G.
Irwin, R. F.
Isenhour, Charles E.
Jackson, Jerome A.
Jackson, Don
Jackson, James R.
Jervis, Larry G.
Johns, Robert B.
Jones, Dennis E.
Jones, Bill
Jones, Johnny
Jones, Jay B.
Jones, Tommie L.
Joslin, Ruth
Juneau, E. J.
Karr, Bob L.
Katibah, G. M.
Kearney, Lewis
Kearns, Howard O.
Keel, Freddie
Kehler, Lynn
Keller, John E.
Kellett, R. W.
Kelley, J. David
Kellison, Robert
Kelly, Thomas H.
Kelly, E. J.
Kendall, Jane C.
Ketcham, Red
Kilian, Leonard A., Jr.

King, Charles N.
King, Clarence F., Jr.
Kinsey, Alva D., Jr.
Kirkland, Red
Kirkwood, R.
Kittle, Paul
Kockenmeister, H.
Koenig, James F.
Kohlmeyer, Jan
Kramer, U. L.
Krochmal, Arnold
Krochmal, Connie
Kruse, Dwayne
Kushner, Adele
Kyle, Water
Lacour, Henry J., Jr.
Ladner, R. L.
Land, Tommie Gene
Land, Samuel B., Jr.
Landers, Larry
Landin, Mary C.
Landrum, J. C.
Langford, Lyndon L.
Langley, Jack
Larson, Dave
Latham, Richard L.
Layssard, Maidie
Layssard, Charles R.
Lee, Bob
Lee, Jimmy
Lee, Jinny Maureen
Legg, Michael H.
Lelong, Michel G.
Lemay, James
Lewis, William Hoke
Lilley, G. D.
Lincer, Jeffrey L.
Lister, Vinnie
Lister, C. H.
Little, Roy A.
Little, T. D.
Livesay, Marcia W.
Lodrige, Joseph L.
Long, Chris
Loo, Wade T.
Louallen, Ricky
Lowery, Robert
Luper, James H.
Lutenbacher, Mark G.
Mabry, Larry G.
Maddux, Thomas L.
Maggi, Rich
Maguire, Mike
Mahagan, John K.
Mahan, William E.
Main, Alden C.
Maltbie, Dorothy P.
Mangan, Becky
Mannchen, Brandt
Maple, William R.
Martin, William H.
Martin, J. M.
Mather, Charles M.
Matthews, Gary W.
McBride, David A.
McCaa, James P.
McCaughan, Russell
McClinton, H. F.
McCoy, Kathryn C.
McCrone, John
McDavid, Raymond H.
McDowell, G. W.
McGinty, Douglas T.
McGrady, Charles W.
McGuire, Diane
McKim, Robert L.
McKim, Eleanor
McLaughlin, Beverly
McLeod, George K.
Mead, James
Mead, Ruth
Means, D. Bruce
Meekins, W. L., Sr.
Merriott, J. Frost
Mielke, Lewis H.
Mikell, Richard B.
Millar, Richard H.
Miller, Leo
Miller, Michael A.
Miller, Patrick
Milliff, Matt
Mitchell, Bob
Mize, Floyd H.
Mobley, Edgar
Montgomery, Jane R.
Moore, Jerome
Moore, John W.
Morgan, H. C., Jr.
Morgan, Ricky E.
Morgan, Robert
Moseley, Bill
Mrazek, Bill
Mrazek, Lynda
Mulholland, Fred W.
Murdoch, Marianne
Murphy, Sue A.
Murray, James R.
Mustian, A. P., Jr.
Myer, Karen
Myers, J. Walter, Jr.
Nahikian, Nick
Nance, M. M., Jr.
Naylor, James F., Jr.
Nelsyn, Wade
Nichols, Robert
Nicholson, Albert R.
Noland, Stewart
Norman, James E.
O'Toole, Randal Lee
Ochsner, Herbert E.
Oglesbee, J. H.
O'Laughlin, Jay
Oliveria, Forrest L.
Olsen, Orland S., Jr.
Olson, John M.
Oravec, Eugene V.
Oviatt-Lawrence, Alice
Owen, Leon D.
Owens, John V.
Owens, Nancy L.
Padgett, James R.
Page, Lavon B.
Palmer, Elige
Papania, Ken
Paradise, Brian
Parham, Glen
Parker, Cordray
Parker, Tim A.
Parrish, Allie Ruth
Paschal, Lawrence W., Jr.
Paul, Michel N.
Pawelczyk, Harry T.
Payne, James L., Jr.
Paysinger, C. T.
Peck, Henry
Penland, David
Pennington, Roy M.
Perdue, L. Donovan
Perkins, Bretta
Petrick, Edity W.
Phillips, T. G.
Phillips, James
Pickering, Mike
Pinckard, Gerald W.
Polley, James
Poole, Lane G.
Poole, James F.
Pope, Bill
Porterfield, Dick

Potts, J. D.
Powell, Peggy
Prewitt, Terrell G.
Price, Charles S.
Ragsdale, Walter
Ragsdale, Susan
Railey, Patrick G.
Ratto, David B.
Raulston, Marvin E.
Ray, Hurlon C.
Ray, Blaine
Raymond, Lynn
Raynes, Martin
Reasor, J. Dan
Reed, Helen T.
Reice, Seth
Reich, Robert S.
Reichardt, Lowell K., Sr.
Reid, Elberta G.
Reid, Robert R., Jr.
Remmers, Galen H.
Renwick, George
Retan, J. Walden
Rex, Merrill R.
Richard, Jack R.
Richards, Paul W.
Richardson, Jack
Richardson, Curtis J.
Ripley-Hager, Brian K.
Rippeteau, Bruce E.
Rivers, Martin E.
Robertson, Dennis
Rockwood, Don
Rodgers, Elizabeth B.
Rollock, Kenneth
Rosemier, Dick L.
Ross, J. L.
Rowe, Hugh D.
Rudis, Victor A.
Runk, Christopher
Runkle, John D.
Runner, Frances W.
Russell, Michael W.
Ryan, William
Ryan, Ted
Ryerson, Richard D.
Salinas, Ana
Sanchez, J.
Sapp, Joe E.
Saucier, Joseph M.
Saunders, Shell
Sawyer, Don
Scarborough, Ruth

Scarborough, Jeff
Schary, Richard
Schell, Kerry F.
Schmidt, D. M.
Schneider, Rachel G.
Scott, Gilbert
Secord, Reed
Sell, Clark
Sharpe, Terry
Shelton, Larry D.
Shepard, Mike
Sherrod, John
Short, Shelton H.
Showalter, George B.
Shupe, Brian
Simmons, Sedgwick
Simpson, Dwayne H.
Smart, Charles W.
Smistik, Robert
Smith, Archer D.
Smith, Bobby Coy
Smith, Gary S.
Smith, Herrick H.
Smith, I. G.
Smith, James D.
Smith, Royce
Smith, Walton R.
Smith, W. J.
Smotherman, L. B.
Snipes, Robert L.
Somers, George W.
Somers, Ann B.
Sonnenfeld, J.
Sparnight, Roderick E.
Spraggins, Robin Lee
Staff, Michael D.
Stafford, Nancy I.
Stahl, David E.
Stalling, Dick
Stebor, Anderson
Steitz, Henry E.
Stelman, Teresa M.
Stephenson, Joey
Stevenson, Walter H.
Stewart, Jimmy, Sr.
Stewart, Robert A.
Stewart, William P.
Still, Hugh R.
Stirewalt, Martha
Stokes, Mickey A.
Stout, Jack
Strader, Robert W.
Stradt, Tom H.
Sullins, Jessie

Sundheimer, Paul W.
Swanson, John R.
Swanzy, Jim
Swindell, T. C.
Swindle, Ranzie
Swindle, Archie
Swindle, Roosevelt
Swindle, Zephaniah
Switzer, George L.
Talton, Bobby O.
Taylor, John N.
Taylor, Nelson
Taylor, W. B.
Tebo, Mary E.
Templeton, Beverly
Lemay, James H.
Teska, Bill
Teston, Gary W.
Thielges, Bart
Thill, Ronald E.
Thomas, Charlie A.
Thomas, William R., Jr.
Thomas, Paul O.
Thomas, R. Dale
Thompson, David
Thompson, Emmett
Thompson, Forrest S.
Thompson, Jesse C.
Thorn, Jerry
Tindall, N. L.
Townsend, Janet
Trotter, George W.
Trotty, Ike
True, M. G.
Uehling, Edward R.
Ursic, Stan J.
Vandersteen, Charles A.
Vanfosson, Ralph F.
Van Wyck, Roger C.
Vessels, Jimmie
Vidrine, Levie
Voigts, David K.
Waldep, Melinda M.
Ward, Ray O.
Warny, Peter R.
Waterhouse, Joe
Watkins, Marvin H.
Watson, Ray
Watt, Donald R.
Watterson, Kenneth G.
Weaver, David
Weaver, Stephen P.
Weisner, William W.

Welborn, Jim
Wells, Carolyn
Welsh, John F.
Westphal, Joanne
Whaley, O. Clodene
White, J. C.
White, H. W.
Whitmore, Roy
Whitney, Charles G.
Wiggs, Tim
Willard, George P.
William, Alva B.
Williams, R. Trent
Williams, Jerry
Williams, Lawrence T., Jr.
Williams, Robert F.
Williams, Robert T.
Willis, Lee E.
Winfree, Vance
Winkelmann, Roy K.
Winkler, Fred
Wise, Arlow
Wise, Raye
Wofsy, Sheila
Wood, Anna Faye
Wright, Harry R.
Young, Charles H.
Zedaker, Shep
Zontek, Frank

Libraries

Central Florida Regional
Florida State University
International Paper
International Paper Research
Kimberly - Clark
Louisiana Collection
SOUTHFORNET
Univ. of North Florida
USDA National Agricultural
WESTFORNET
WESTVACO - FSL
Weyerhaeuser Research Center
Weyerhaeuser SFRC

Media

Gordon Baxter, Freelance
The Clarion Ledger, MS
Denton-Record, NC
The Florida Cattleman
The Independent
LA Femme Newspaper, FL
News and Record, NC
Richmond Times Dispatch, VA
The Times, NC
WVMF/WLKF Radio, FL

Minority Organizations

Black Chamber of Commerce, AR
Cheyenne-Arapaho Business Comm.
Chitimacha Tribal Council
Creek Nation of OK
Eastern Band of Cherokee Indians
Emergency Land Fund/Nat.
Houston Area Urban League
League of Women Voters, GA
NAACP, FL
NAACP, GA
NAACP, SC
National Urban League, GA
OIC - Opportunity Industrial, GA
OTOE - Missouria Business Comm., OK
Pawnee Business Council, OK
Potawatomi Business Comm., OK
Quapaw Business Comm., OK
Tonkawa Busines Comm., OK
Urban League of AR

Organizations

Alabama Conservancy
Alabama Conservation - Federated Clubs
Alabama Forestry Association
Alabama Garden Clubs
American Camping Associationn
American Forest Council
American Forestry Association
American Motorcycle Association
American Petroleum Institute
American Plywood Association
American Pulpwood Association
American Society of Landscape Architects
Animal Rights Kinship
Appalachian Consortium
Appalachian Trail Conference
Balsam Highlands Task Force
Bonnet Carre Rod and Gun
Carteret Wildlife Club
Charleston Natural History Society
Citizens Environmental Council - VA
Claiborne Hunt and Fishing Club
Common Sense Army

Conservation Council of NC
Earth First! - FL, TX, VA
Environmental Law Institute
Farm Bureau - MS, TX
Florida Dog Hunters Association
Florida Forestry Association
Florida Native Plant Society
Florida Trail Association
Forest Farmers Association
Forest Service Timber Purchasers
Foundation for NC Archaeology
Friends of the Mountains
Gopher Tortoise Council
Institute of Government
International Forestsearch
Izaak Walton League - NC, VA
John Rob Fork Hunt Club
Keep Kisatchie Coalition
Land-of-Sky Regional Council
Leaf River Deer Club
Louisiana Forestry Association
Manasota - 88
Mid-Continent Oil and Gas Association
Mississippi Forestry Association
National Association of Conservation District
National Audubon Society - Baton Rouge, LA - Bay County, FL - Charleston, SC - Dallas, TX - Nacodoches County, TX - Naples, FL
National Campers and Hikers Association
National Forest Products Association
National Wildlife Federation - AL, DC, MS
National Wild Turkey Federation - FL, NC, SC
Nature Conservancy - FL, GA, NC, SC, VA
Neuse River Foundation
Ozark Society
Sabine - San Augustine Landowners
San Jacinto Forest Landowners
Sierra Club - Arkansas Chapter - Athens, GA - Cahaba Group - Conservation Council - Delta Chapter - Central Piedmont - Florida - Kisatchie Group - Legal Defense Fund - Lone Star Chapter - North Carolina - South Carolina - South Central States Office
Society of American Foresters
Southeast Fisheries Council
Southern Forest Products Association
South Mississippi Sportsman
Swan View Coalition
Tall Timbers Research
Texas Conservancy Coalition
Texas Conservation Foundation
Texas Commission on Natural Resources
Texas Endurance Riders Association
Trees for Tomorrow
Trinity Forest Landowners Association
Trout Unlimited - GA - Fisherville, VA - Vienna, VA
Umstead Coalition
Walker County Forest Landowners Association
Wildlife Management Institute - TN, TX, DC
Wildlife Society - FL, NC
Yale Forest Management Study Group
YMCA - Southeast Region

State and Local Government - Alabama

Cooperative Extension Service
Department of Conservation and Natural Resources
Forestry Commission
Game and Fish Division
Historical Commission
State Conservation Officer
St. Clair County Board of Education
Talladega Water and Sewage
Town of Brookside

State and Local Government - Arkansas

Cooperative Extension Service
Forestry Commission

State and Local Government - Florida

Apalachee Regional Planning Commission
City of Tallahassee
Cooperative Extension Service
Department of Environmental Regulation
Department of Natural Resources
Department of Transportation
Division of Forestry
East-Central Regional Planning Commission
Governor's Office
Natural Areas Inventory
NE Regional Planning Council
NW Water Management District
SW Water Management District

State and Local Government - Georgia

Cooperative Extension Service
Department of Natural Resources
Forestry Commission
Natural Heritage Inventory

State and Local Government - Kentucky

Cooperative Extension Service
Division of Forestry

State and Local Government - Louisiana

Air Control Commission
Cooperative Extension Service
Department of Culture, Recreation and Tourism
Department of Wildlife and Fisheries
Office of Forestry - DNR

State and Local Government - Maryland

Cooperative Extension Service

State and Local Government - Mississippi

City of Rolling Fork
Cooperative Extension Service
Department of Wildlife Conservation
Forestry Commission
Highway Department
Military Department
Oil and Gas Board
Southwest EPA
State Clearinghouse

State and Local Government - North Carolina

Botanical Garden
Carteret County
City of Beaufort
City of Marion
Cooperative Extension Service
Craven County
Division of Forest Resources
Maritime Museum
Mecklenburg County Parks and Recreation
NRCD - Coastal Management
NRCD - Natural Heritage Program
NRCD - Water Resources
State Clearinghouse
State Historic Preservation Officer
State Museum of Natural Science
Western Piedmont Council of Governments
Wildlife Resources Commission

State and Local Government - Oklahoma

Cooperative Extension Service
Forestry Division

State and Local Government - South Carolina

Cooperative Extension Service
Forestry Commission
Heritage Trust
Land Resources Commission
Newberry Soil and Water Conservation District
Parks, Recreation and Tourism
Wildlife and Marine Resources Department

State and Local Government - Virginia

Cooperative Extension Service
Council on the Environment
Department of Forestry

State and Local Government - Tennessee

Cooperative Extension Service
Division of Forestry

State and Local Government - Texas

Cooperative Extension Service
Forest Service
Houston County
Parks and Wildlife Department
San Augustine County
Shelby County
Walker County
Wise Soil and Water Conservation District

Glossary

CHAPTER VII

GLOSSARY

Active ingredient (a.i.).--The effective part of a pesticide formulation, or the actual amount of the technical material present in the formulation.

Acute toxicity.--The toxicity of a compound when given in a single dose or in multiple doses over a period of 24 hours or less. The quality or potential of a substance to cause injury or illness shortly after exposure to a relatively large dose.

Adjuvant-additive.--Something added to the pesticide mixture to help the active ingredient do a better job. Examples: wetting agent, spreader, adhesive, emulsifying agent, penetrant.

a.i.--See Active ingredient.

Allelopathic.--Pertaining to the suppression of growth of one plant species by another through the release of toxic substances.

Amine.--Any of a group of organic compounds of nitrogen, such as ethylamine, $C_2H_5NH_2$, that may be considered ammonia derivatives in which one or more hydrogen atoms have been replaced by a hydrocarbon radical.

Animal unit month (AUM).--The amount of feed or forage required by an animal unit for one month.

Annual (plant).--A plant species living and growing for only 1 year or season.

Aquifer.--An underground zone of earth or rock saturated with water whose upper limit is the water table.

AUM.--See Animal unit month.

Biennial (plant).--A plant species that completes its life cycle, from seed germination to seed production, in 2 years. Also means "to occur every 2 years," as in biennial burns.

Bioaccumulation.--The process of a plant or animal selectively taking in or storing a persistent substance. Over a period of time, a higher concentration of the substance is found in the organism than in the organism's environment.

Biological control.--Pest control without the use of chemicals. Parasites, predators, diseases, etc. are used to control pests.

Biological opinion.--An official report by the Fish and Wildlife Service (FWS) or the National Marine Fisheries Service (NMFS) issued in response to a formal Forest

Service request for consultation or conference. It states whether an action is likely to result in jeopardy to a species or adverse modification of its critical habitat.

Biomass.--The total amount (weight) of living material in a given habitat.

Broadcast application.--Uniform distribution of an herbicide over an entire area.

Broadleaf weed.--A nonwoody dicotyledonous plant with wide bladed leaves designated as a pest species in gardens, farms, or forests.

Browse.--That part of leaf and twig growth of shrubs, woody vines, and trees on which browsing animals can feed; to consume browse.

Buffer strip.--A strip of vegetation that is left unmanaged or is managed to reduce the impact that a treatment or action on one area would have on an adjacent area.

Canopy.--The cover of branches and foliage formed collectively by the crowns of adjacent trees and other woody growth.

Carcinogenic.--Producing or inciting cancer.

Chemical degradation.--The breakdown of a chemical substance into simpler components through chemical reactions.

Chronic toxicity.--How poisonous a pesticide is to an animal (or man) after small, repeated doses over a period of time.

Class I area.--One of three classes of areas provided for in the Clean Air Act for the Prevention of Significant Deterioration program. Class I areas are the "cleanest" area and receive special visibility protection. They are allowed very limited increases (increments) in sulfur dioxide and particulate matter concentrations in the ambient air over baseline concentrations. (See 42 U.S.C. 7473 for description of the specific increments).

Conifer.--An order of the Gymnospermae, comprising a wide range of trees, mostly evergreens that bear cones and have needle-shaped or scalelike leaves; timber commercially identified as softwood.

Deciduous.--Pertaining to any plant organ or group of organs that is shed naturally; perennial plants that are leafless for some time during the year.

Diversity.--The distribution and abundance of different plant and animal communities and species within the area covered by a land and resource management plan.

Dose.--The amount of chemical administered or received by an organism, generally at a given point in time.

Drift.--That portion of a sprayed chemical that is moved by wind off a target site.

Duff.--The lower portion of the organic layer covering the soil, consisting of decomposed litter.

Ecological niche.--The physical space in a habitat occupied by an organism; its functional role in a community; and its position in environmental gradients of temperature, moisture, pH, soil, and other conditions of existence.

Ecosystem.--The system formed by the interaction of a group of organisms and their environment.

Ecotone.--The place where plant communities meet or where successional stages of vegetative conditions within plant communities come together; for example, a forest edge.

Edge.--The more or less well-defined boundary between two or more elements of the environment; for example, field/woodland.

Endangered species.--Any species that is in danger of extinction throughout all or a significant part of its range. Endangered species must be designated in the Federal Register by the appropriate Secretary. (See Threatened species.)

Ephemeral stream.--A stream that flows less than 10 percent of the time, only in direct response to rainfall, whose channel is always above the water table.

Ester.--A compound formed by the reaction of an acid and an alcohol, generally accompanied by the elimination of water.

Exposure.--The amount of contact with a pesticide.

FIFRA.--Federal Insecticide, Fungicide and Rodenticide Act (1948, amended 1972, 1975, 1978).

Forage.--All browse and nonwoody plants available to livestock or wildlife for grazing or harvested for feed.

Forb.--Any herbaceous plant other than grass or grasslike plants.

Foreground.--A term used in visual resource management to describe the visible terrain in which individual details of the landscape can be perceived, usually up to 1/4-1/2 mile from the observer.

Formulation.--The form in which a pesticide is packaged or prepared for use. A chemical mixture that includes a certain percentage of active ingredient (technical chemical) with an inert carrier.

Fuel.--Living or dead plant material that will burn.

Habitat.--The natural environment of a plant or animal. An animal's habitat includes the total environmental conditions for food, cover, and water within its home range.

Half-life.--The time required for half the amount of substance (such as a herbicide) in or introduced into a living system to be eliminated whether by excretion, metabolic decomposition, or other natural process.

Hazard.--The risk of danger; the chance that danger or harm will come to the applicator, bystanders, consumers, livestock, wildlife or crops, etc.

Herbaceous.--A plant that does not develop persistent woody tissue above the ground.

Herbicide.--A chemical used to control, suppress, or kill plants, or to severely interrupt their normal growth processes.

Hydrolysis.--Decomposition or alteration of a chemical substance by water.

Inert ingredients.--All ingredients in a forumlated pesticide product which are not classified as active ingredients. Note that inert as used here is a defined usage; many inert products are biologically active chemicals.

Intermittent Stream.--A stream that flows seasonally (10-90 percent of the time) in response to a fluctuating water table, whose channel is at least 3 feet wide.

Label.--All printed material on or attached to a pesticide container as required by law.

Landtype.--A land area with distinct topography, geology, and runoff-erosion response to management.

LC$_{50}$.--See Lethal concentration$_{50}$.

LD$_{50}$.--See Lethal dose$_{50}$.

Lethal concentration$_{50}$(LC$_{50}$).--The concentration of a chemical at which 50 percent of the test animals will be killed. It is usually used in testing of fish or other aquatic animals.

Lethal dose$_{50}$(LD$_{50}$).--Median lethal dose, is the milligram of toxicant per kilogram of animal body weight (mg/kg) lethal to 50 percent of the test animals to which it is administered under the conditions of the experiment.

Median lethal dose, is the milligram of toxicant per kilogram of animal body weight (mg/kg) lethal to 50 percent of the test animals to which it is administered under the conditions of the experiment.

Litter.--The upper portion of the organic layer covering the soil, consisting of unaltered dead remains of plants and animals whose original form is still visible.

Margin of safety (MOS).--The ratio between the animal no observed effect level (NOEL) and the estimated human dose. The larger the MOS, the smaller the estimated human dose and the lower the risk to human health.

Meristem.--The growing point or area of rapidly dividing cells at the tip of a stem, root, or branch.

Microbial degradation.--The breakdown of a chemical substance into similer components by bacteria.

Multiple use.--The management of all the various renewable surface resources of the National Forest System so that they are utilized in the combination that will best meet the needs of the American people; making the most judicious use of the land for some or all of these resources or related services over areas large enough to provide

sufficient latitude for periodic adjustments in use to conform to changing needs and conditions; that some lands will be used for less than all of the resources, each with the other, without impairment of the productivity of the land, with consideration being given to the relative values of the various resources, and not necessarily the combination of the uses that will give the greatest dollar return or the greatest unit output.

Mutagenicity.--The capacity of a substance to cause changes in genetic material.

National Environmental Policy Act (NEPA).--Establishes a national policy to encourage productive and enjoyable harmony between man and the environment, to promote efforts that will prevent or eliminate damage to the environment and stimulate the health and welfare of man, to enrich the understanding of the ecological systems and natural resources important to the nation, and to establish a Council on Environmental Quality.

National forest land and resource management plan.--A plan developed to meet the requirements of the Forest and Rangeland Renewable Resources Planning Act of 1974, as amended (95-125, 129, 130). This plan guides all natural resource management activities, and establishes management activities, standards, and guidelines for each national forest.

Natural regeneration.--The renewal of a tree crop by natural means, or without efforts to seed or plant trees. The new trees grow from selfsown seeds or by vegetative means such as root suckers.

NEPA.--See National Environmental Policy Act.

NOEL.--See No-observed-effect-level.

Nontarget.--Any plant, animal, or other organism that a method application is not aimed at, but may acciently be injured by the method.

No-observed-effect-level (NOEL).--In a series of dose levels tested, it is the highest level at which no effect is observed.

Noxious weed.--A plant regulated or identified by law as being undesirable, troublesome, and difficult to control.

Oncogenicity.--Capable of producing or inducing tumors in animals, either benign (noncancerous) or malignant (cancerous).

Opportunity cost.--The net loss, expressed in dollars, resulting from the selection of a less efficient course of action.

Perennial.--A plant species having a lifespan of more than 2 years.

Perennial stream.--A stream that flows year-round (more than 90 percent of the time) and whose channel is always below the water table.

Persistence.--The resistance of a herbicide to metabolism and environmental degradation and thus a herbicide's retention of its ability to kill plants for prolonged periods.

Pesticide.--Any substance or mixture of substances intended for controlling insects, rodents, fungi, weeds, or other forms of plant or animal life that are considered to be pests.

Photodecomposition.--The breakdown of a substance, especially a chemical compound, into simpler components by the action of radiant energy.

Photosynthesis.--Formation of carbohydrates in the tissues of plants exposed to light.

Plant community.--An association of plants of various species found growing together in different areas with similar site characteristics.

Pocosin.--An evergreen shrub bog on a raised plateau, usually removed from large streams yet periodically flooded, with acid, poor sandy or peat soils, in the Atlantic flatwoods (Algonquin: "swamp on a hill").

Poison.--Any chemical or agent that can cause illness or death when eaten, absorbed through the skin, inhaled, or otherwise absorbed by man, animals, or plants. Note that a substance is a poison or not with respect to specific organisms. Animals safely eat many things which are "poisonous" to humans.

Precommercial thinning.--Cutting in immature stands to improve the quality and growth of the remaining stand. None of the felled trees are extracted and utilized.

Protocol.--see Standard.

Pyrolysis.--Chemical breakdown caused in the process of combustion.

Regeneration.--The renewal of a tree crop whether by natural or artificial means. Also, the young crop itself.

Release and weeding.--All work done to free desirable trees from competition with overstory trees, less desirable trees or grasses, and other forms of vegetative growth. It includes incidental disease control work and release of natural and artificial regeneration.

Residue.--The quantity of a herbicide or its metabolites remaining in or on soil, water, plants, animals, or surfaces.

Rhizomes.--A stem, generally modified for storing food materials, that grows along and below the ground surface and that produces adventitious roots, scale leaves, and suckers irregularly along its length, not just at nodes.

Riparian ecosystem.--A riparian ecosystem is a transition between the aquatic ecosystem and the adjacent terrestrial ecosystem and is identified by soil characteristics and distinctive vegetation communities that require free or unbound water.

Risk.--The probability that a substance will produce harm under specified conditions.

Risk analysis.--The description of the nature and often the magnitude of risk to organisms, including attendant uncertainty.

Rotation.--The number of years required to establish and grow a timber crop to a specified condition of maturity. The rotation includes a period for harvesting and stand re-establishment, usually 5 years.

Safety factor.--A factor conventionally used to extrapolate human tolerances for chemical agents from no-observed-effect levels in animal test data.

Scoping.--The process by which significant issues relating to a proposal are identified for environmental analysis. Scoping includes eliciting public comment on the proposal, evaluating concerns, and developing alternatives for consideration.

Shrub.--A plant with persistent woody stems and relatively low growth form; usually produces several basal shoots as opposed to a single bole; differs from a tree by its low stature and nonarborescent form.

Silviculture.--The branch of forestry dealing with the care, development, and reproduction of forest trees or stands of timber.

Site preparation.--The removal of competition (including woody slash) and conditioning of the soil to enhance the survival and growth of seedlings or to enhance the germination of seed.

Species (plural: species).--A morphologically, genetically, and ecologically defined biological entity to which a binomial and authority is given; e.g., Potamogeton filiformis Pers., the slender-leaf Potamogeton.

Stand.--Trees that grow in the same location, and which are fairly uniform in type, age and risk classes, vigor, stand-size class, and stocking class. The similarity of these qualities distinguish the stand from adjacent stands that contain trees with different features.

Standard.--A principle requiring a specific level of attainment; a rule to measure against.

Subchronic.--The effects observed from doses that are of intermediate duration, usually 3 months.

Succession.--The progressive development of trees or other plants toward their highest role in their ecology; their climax. The replacement of one forest, or other plants, by others.

Technical chemical or pesticide.--The pesticide as it is first manufactured by the company before formulation. It is usually almost pure.

Teratogenesis.--The development of abnormal structures in an embryo.

Threshold.--A dose or exposure below which there is no apparent or measurable adverse effect.

Threshold limit value (TLV).--The concentration of an airborne constituent to which workers may be exposed repeatedly, day by day, without adverse effect.

Timber stand improvement (TSI).--Activities conducted in young stands of timber to improve growth rate and form of the remaining trees, includes release and precommercial thinning.

TLV.--See Threshold limit value.

Toxicity.--A characteristic of a substance that makes it poisonous.

TSI.--See Timber stand improvement.

Understory (vegetation).--Shade-tolerant plants growing below the canopy of other plants. Usually refers to grasses, forbs, and low shrubs under a tree or brush canopy.

Visual resource.--The composite of basic terrain, geologic features, water features, vegetative patterns, and land-use effects that typify a land unit and influence the visual appeal the unit may have for visitors.

Watershed.--The entire area that contributes water to a stream or lake.

Wetlands.--Those areas that are inundated by surface or ground water often enough to support plants and other aquatic life that requires saturated or seasonally saturated soils for growth and reproduction. Wetlands generally include swamps, marshes, bogs and similar areas such as sloughs, potholes, wet meadows, river overflows, mud flats, and natural ponds.

WSI.--See Wildlife Stand Improvement.

Wildlife Stand Improvement (WSI).--Activities conducted in timber stands to improve conditions for various wildlife species. Includes release and midstory removal.

References

CHAPTER VIII

CHAPTER VIII

REFERENCES

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